Western Regional Climate Center

Desert Research Institute

The California Climate Tracker:

A New Monitoring Tool

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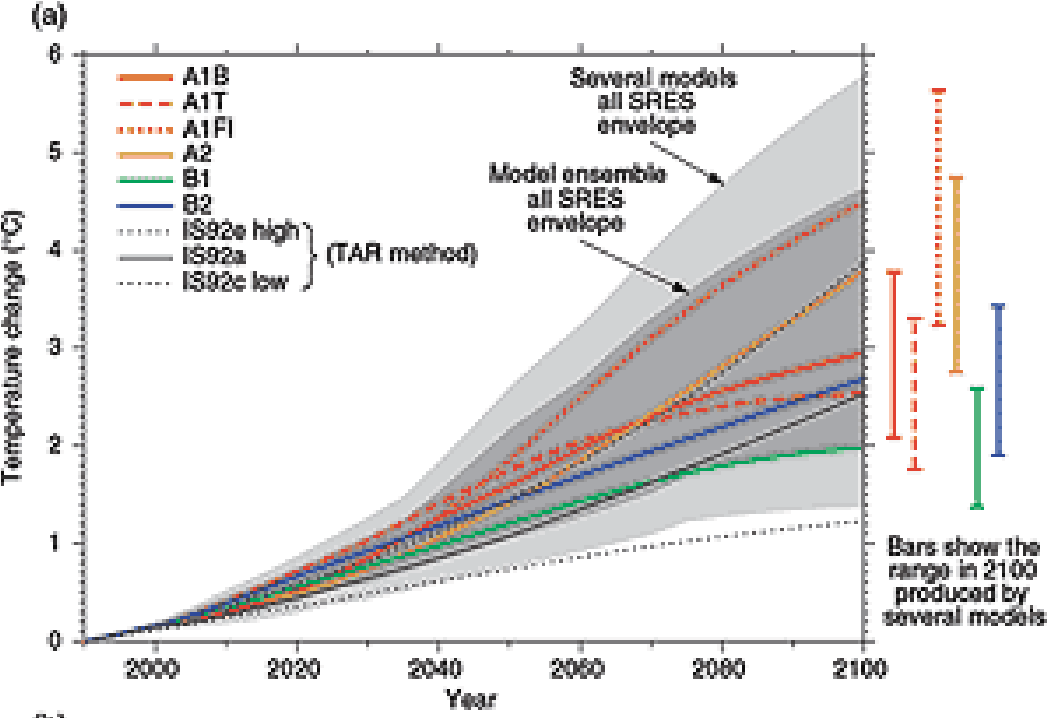
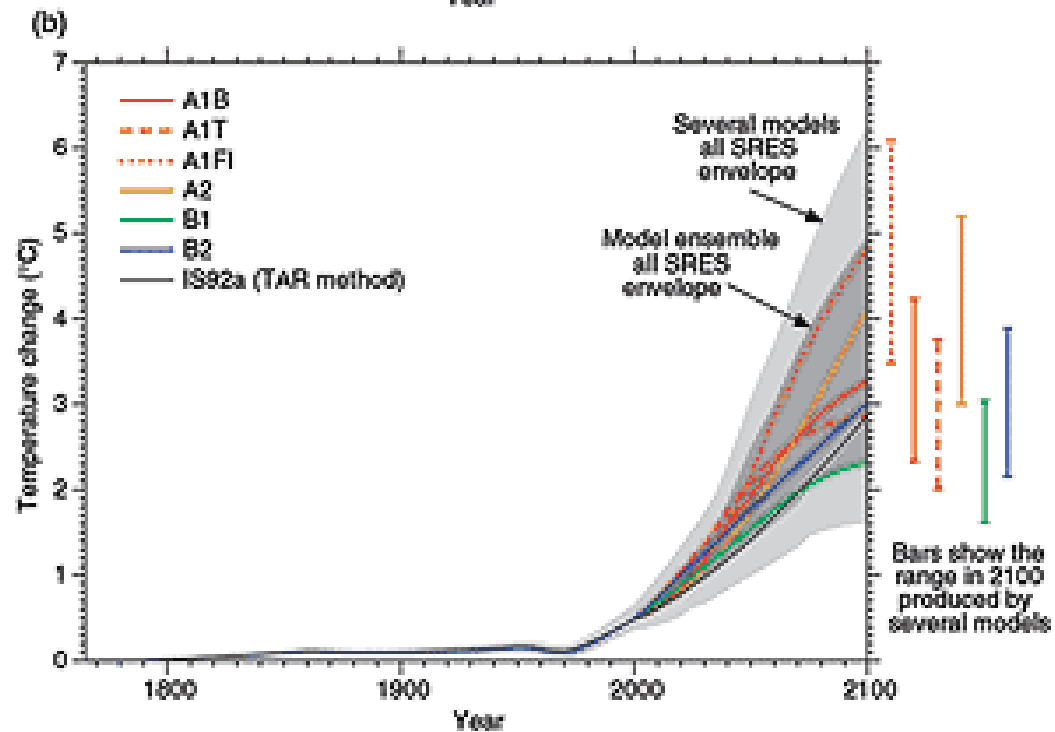
Desert Research Institute
Reno Nevada

California Climate Change Research Conference
Sacramento California 2007 September 10-13
Sponsors: California Energy Commission, CalFed, NOAA WRCC, DRI DAS



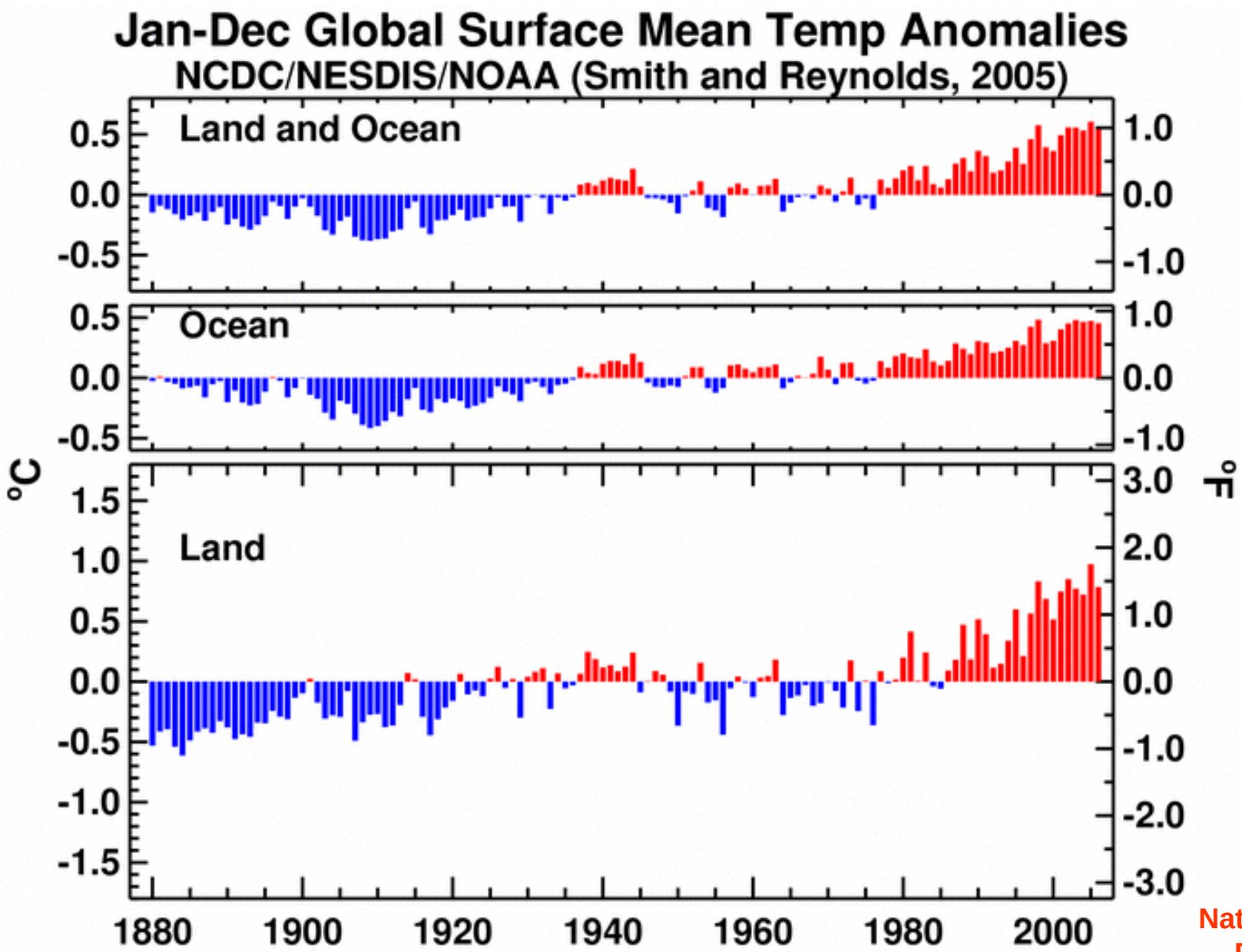


Future Projections

Global Mean Temperature

For various plausible emissions scenarios

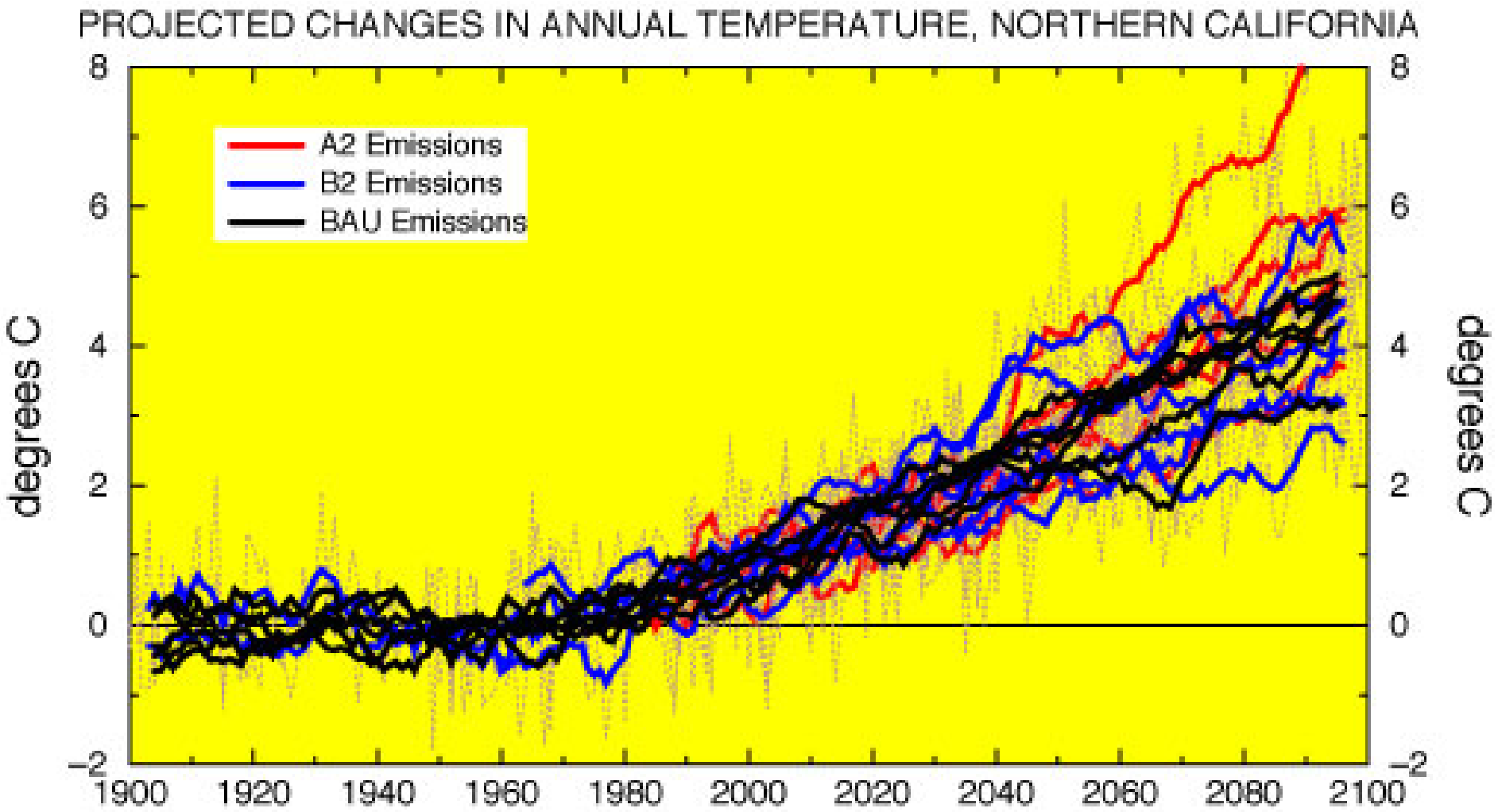
Observations: What's actually been happening ?



NOAA

National Climatic Data Center

Courtesy of Mike Dettinger, USGS / Scripps.



Dettinger MD. 2005. From climate change spaghetti to climate-change distributions for 21st Century California. San Francisco Estuary and Watershed Science. Vol. 3, Issue 1, (March 2005), Article 4. http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art4

Considerations for a California Climate Index system

Tracking California climate through time. For whatever reason, is it changing ???

Recent past: need to put this into longer perspective

Elements of greatest interest: Temperature and Precipitation

Best if a single value that can be remembered

Simple, intuitive, understandable
Audience: The public, news media, managers, legislators, policy, classroom

Should be physically meaningful

Should relate to impacts

Would like measures that correlate well with climate at smaller scales

Monthly update frequency

Should cover at least a century, late 1800s thru present.
Paleo extension to blue oaks if possible.

Use station data or gridded data? Answer: Both.

Considerations for a California Climate Index system (continued)

Geographic complexity requires at least 5-7 regional indicators
- Spatial coherence can vary by month and season
- Spatial coherence can vary by element (temp, precip, wind, solar, etc)

Mountains, coasts, deserts can each have different time histories from those of the interior of California

Seasonal effects of: snow on ground, ocean upwelling, irrigation

Artificial human influences (for example, urban heat islands, irrigation)
- Generally like to avoid these
- However, in some cases need/want actual rather than adjusted values
- Do we "correct" for these effects, or include or highlight them?
- Observation time bias correction may be needed

Maximum and minimum temperatures can have different time histories

Need to be able to update each rapidly and on a schedule
- Need timely, accessible and reliable data (there when needed)

Need lengthy and compatible record from the past
Need for stations not slated for termination
Much prefer unchanging exposure
Must have adjustment methods for dealing with incomplete data

How to determine sub-regions?

Expert judgment

Use existing patterns (for example, climate divisions)

Use objective techniques

- Look for common behavior among station assemblages
- Temporal correlation: "nearby" in behavior, not necessarily geography.
- Clustering and pattern analysis, using EOFs / PCAs
- Perform EOF rotation to produce geographic clusters

Compatibility with crop districts, counties, watersheds, admin boundaries

Corroboration from biomes or other ecological indicators

Analyses must usually be based on standardized values

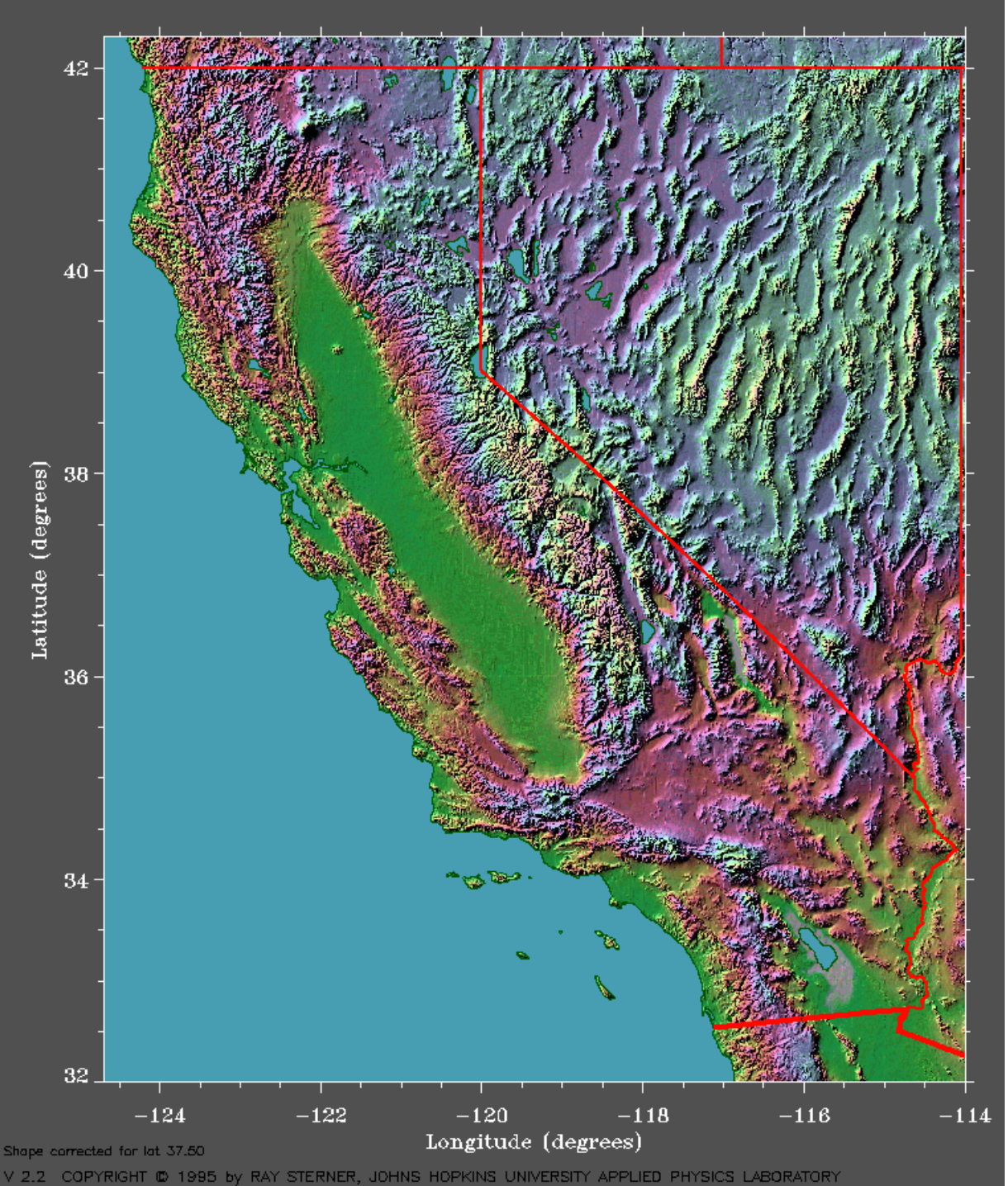
- Reconvert these to common units for presentation and portrayal

For simplicity, we mostly want just one set of sub-regions

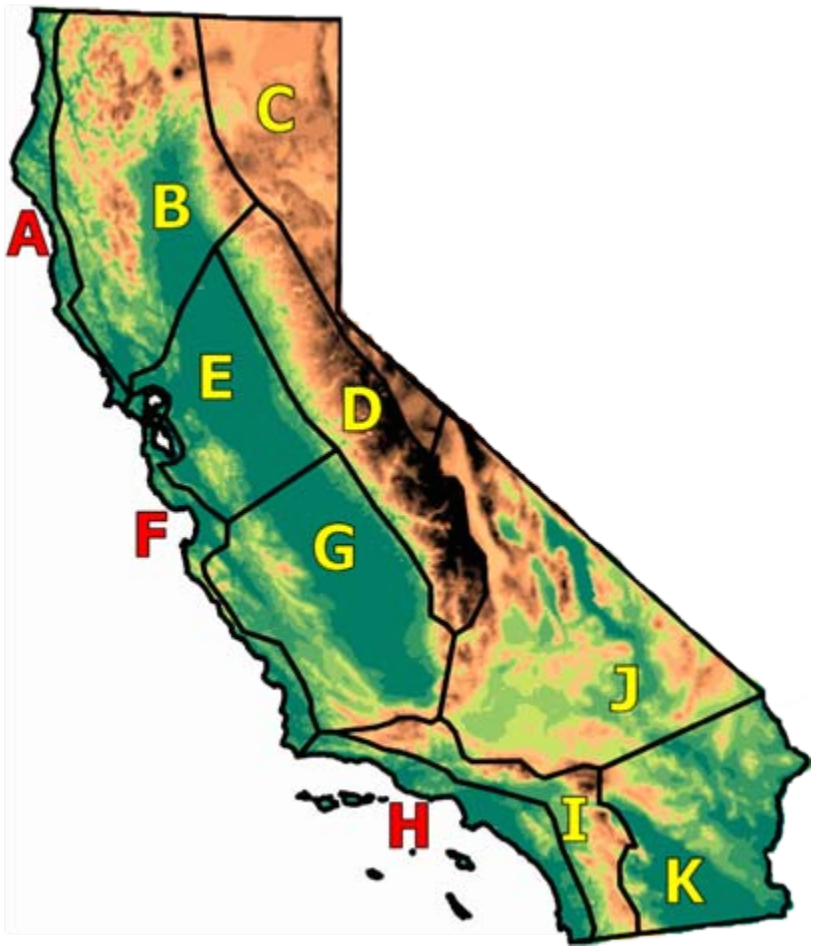
344 U.S. Climate Divisions Monthly 1895-Present

How to portray sub-regions

Can this complexity be distilled …
to this ?



Eleven climate monitoring regions determined from this analysis

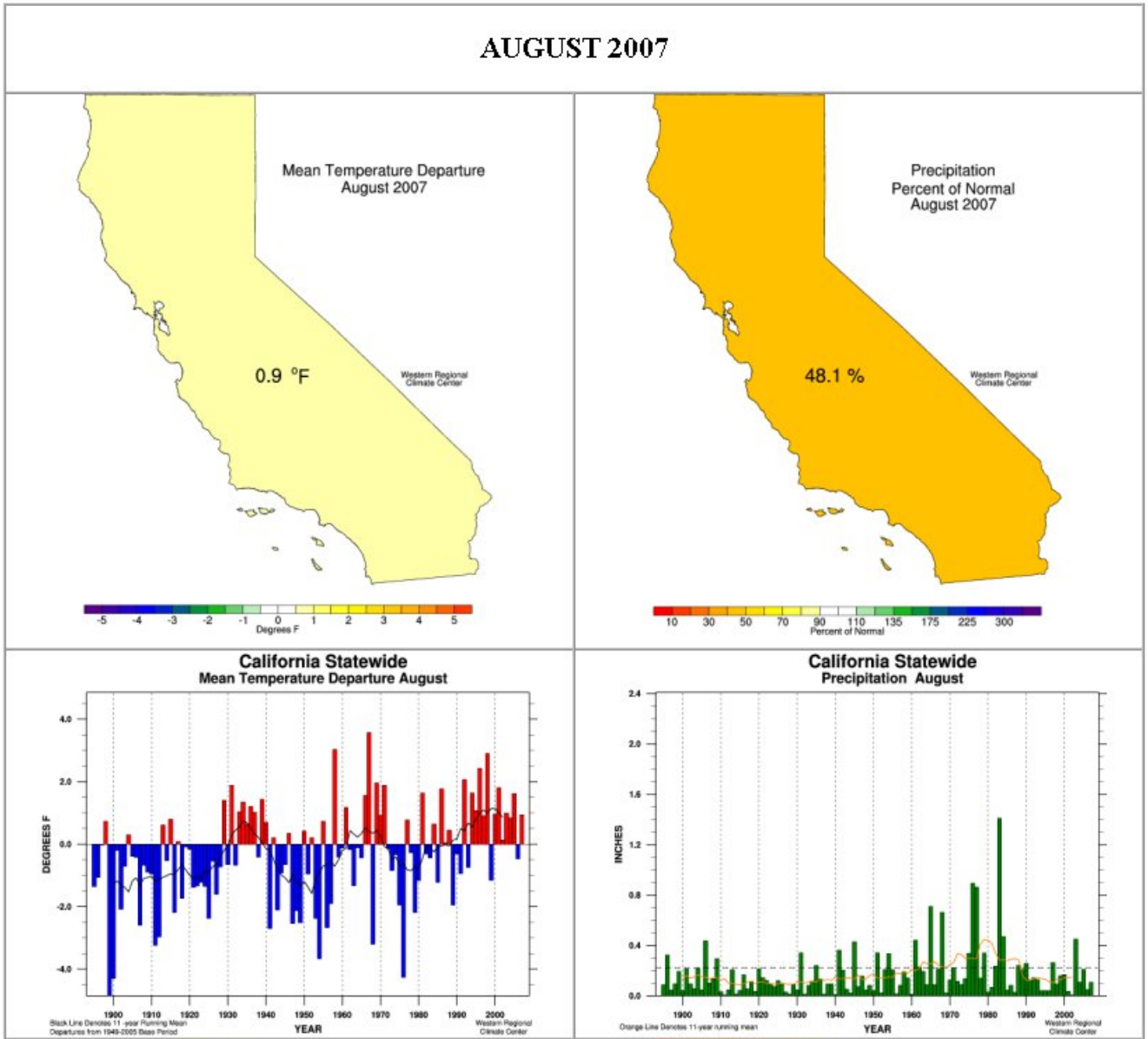


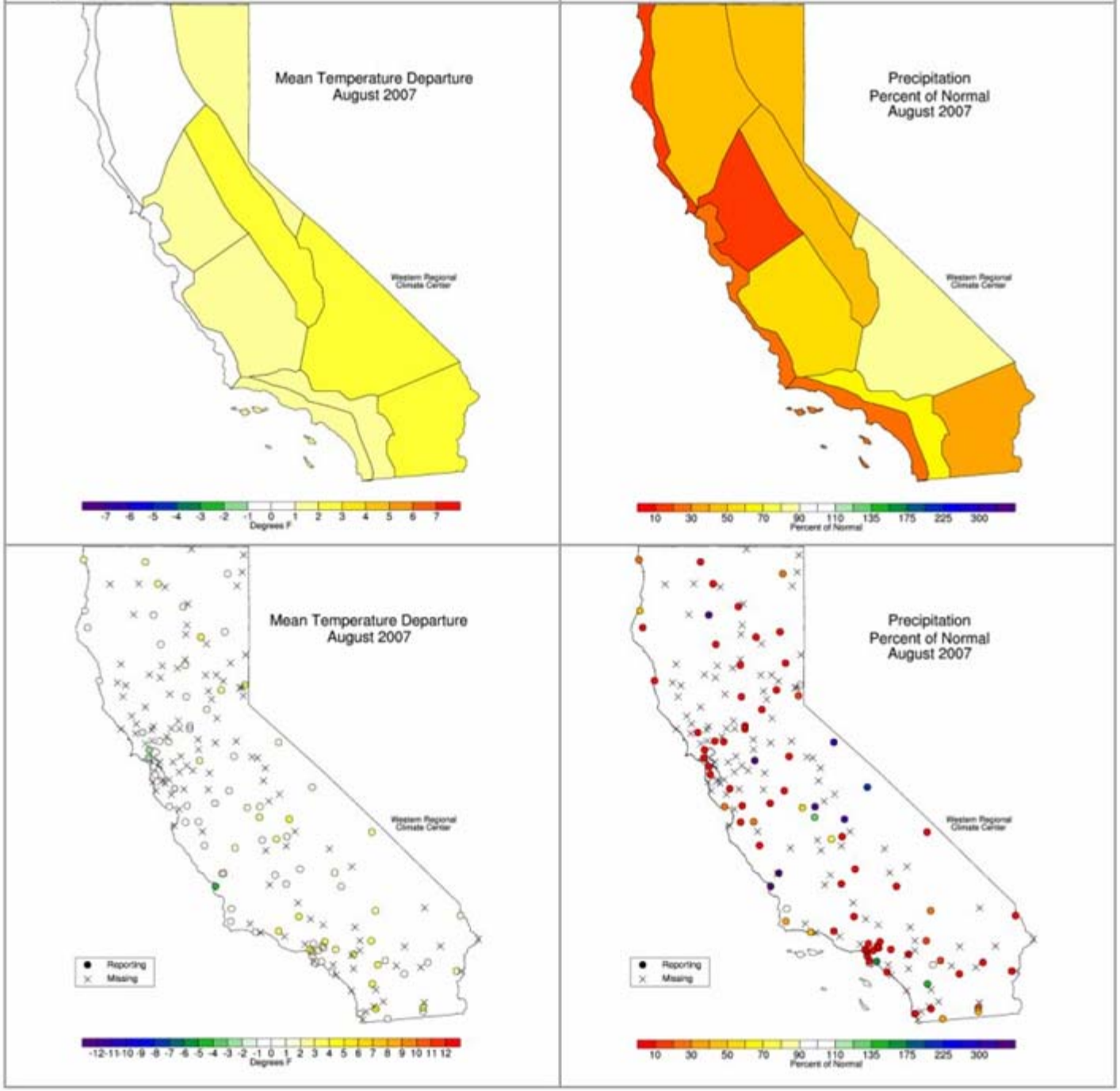
California Climate Tracker

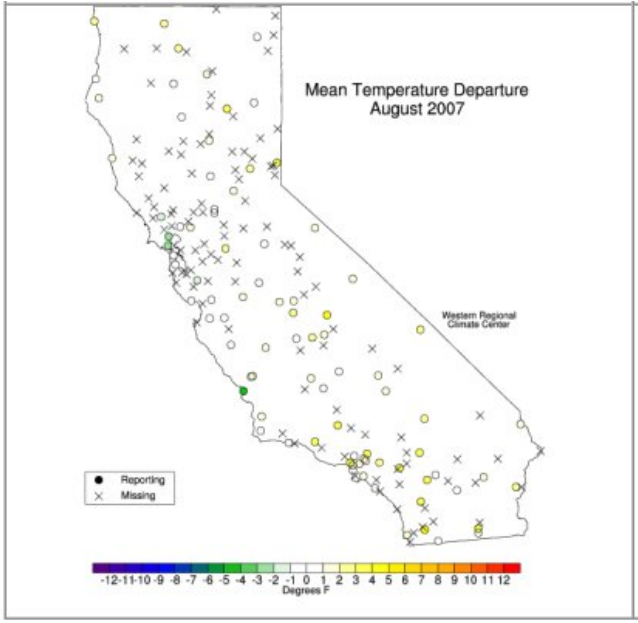
Tracking Climate Variability and Change for the State

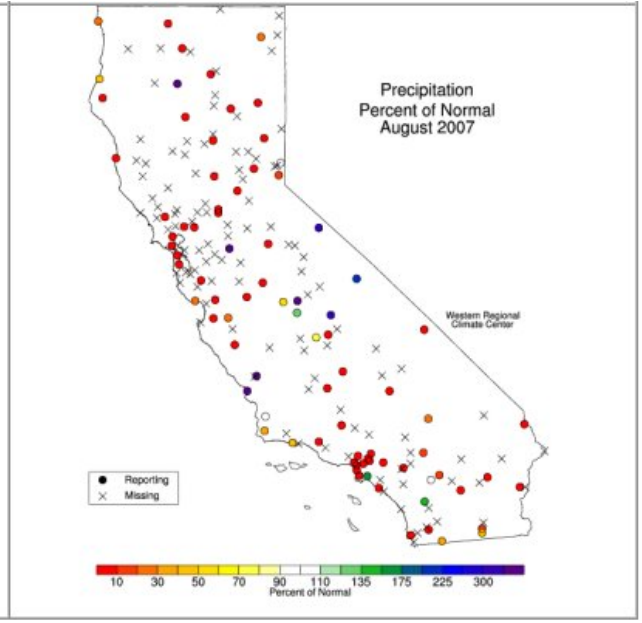
Climate Products Frames Version

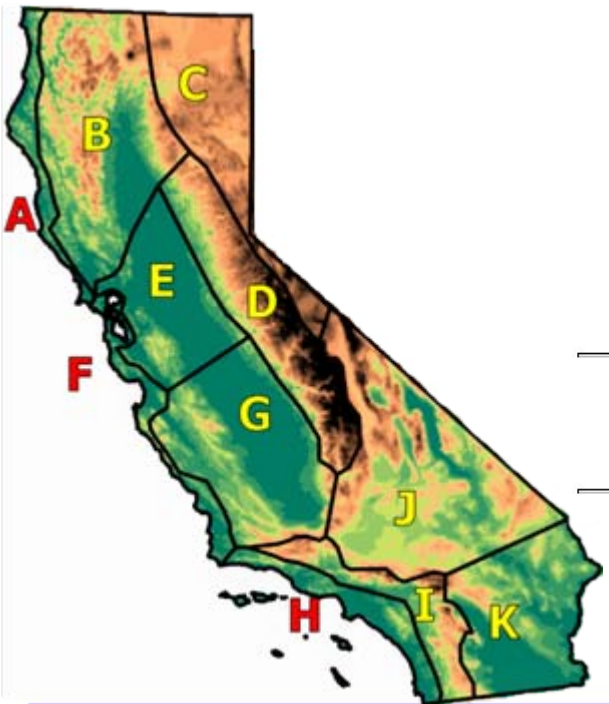
Example: August 2007




Mean Temperature Departure
August 2007
Western Regional Climate Center
-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7
Degrees F
Precipitation
Percent of Normal
August 2007
Western Regional Climate Center
10 30 50 70 90 110 135 175 225 300
Percent of Normal
Mean Temperature Departure
August 2007
Western Regional Climate Center
Reporting
Missing
-12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12
Degrees F
Precipitation
Percent of Normal
August 2007
Western Regional Climate Center
Reporting
Missing
10 30 50 70 90 110 135 175 225 300
Percent of Normal







Detailed Climate Products:

NEW Climate Products Frames Version NEW

or

Choose from:

Latest Graphics

Select a Variable | GET VARIABLE

Climate Time Series

Select a Region | GET REGION

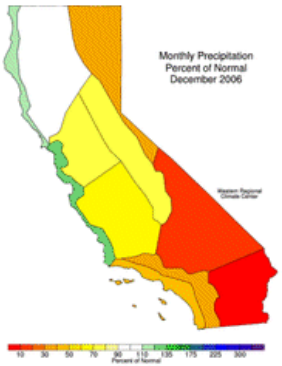
Summary of Past 12 Months

Select a Region | GET REGION

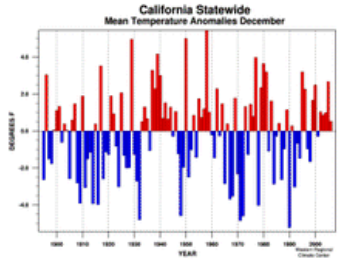
California Climate Tracker

Select from the Menu to the Right

Latest Graphics



Time Series



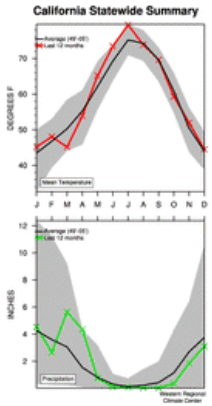
Latest Graphics

Select Region
Select Element
Select Data Type
Select Time Period
Select

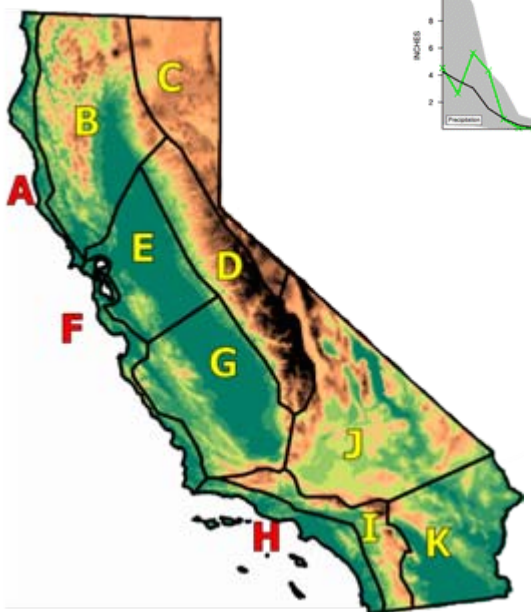
Time Series

Select Region
Select Element
Select Time Period
Select

Last 12 Months



- Climate region data: 1895 to present
- Averages taken from: 1949-2005



Time Series

Select Region
Statewide
Sierra
Northeast
North Central
Sacramento-Delta
San Joaquin Valley
North Coast
Central Coast
South Coast
South Interior
Mohave
Sonoran

Time Series

Select Region
Select Element
Select Element
Maximum Temperature
Minimum Temperature
Mean Temperature
Precipitation
Temperature Summary

Time Series

Select Region
Select Element
Select Time Period
March
April
May
June
July
August
September
October
November
December
Winter (DJF)
Spring (MAM)
Summer (JJA)
Autumn (SON)
Calendar Year (Jan-Dec)
Water Year (Oct-Sep)
Water Year (Jul-Jun)
January to Present
October To Present
July To Present

Summary of the Past 12 Months

Select Region GO

Climate Regions
Plot Data

More Info
Retrieve Data

Back to the California Climate Tracker
Non-Frames Version

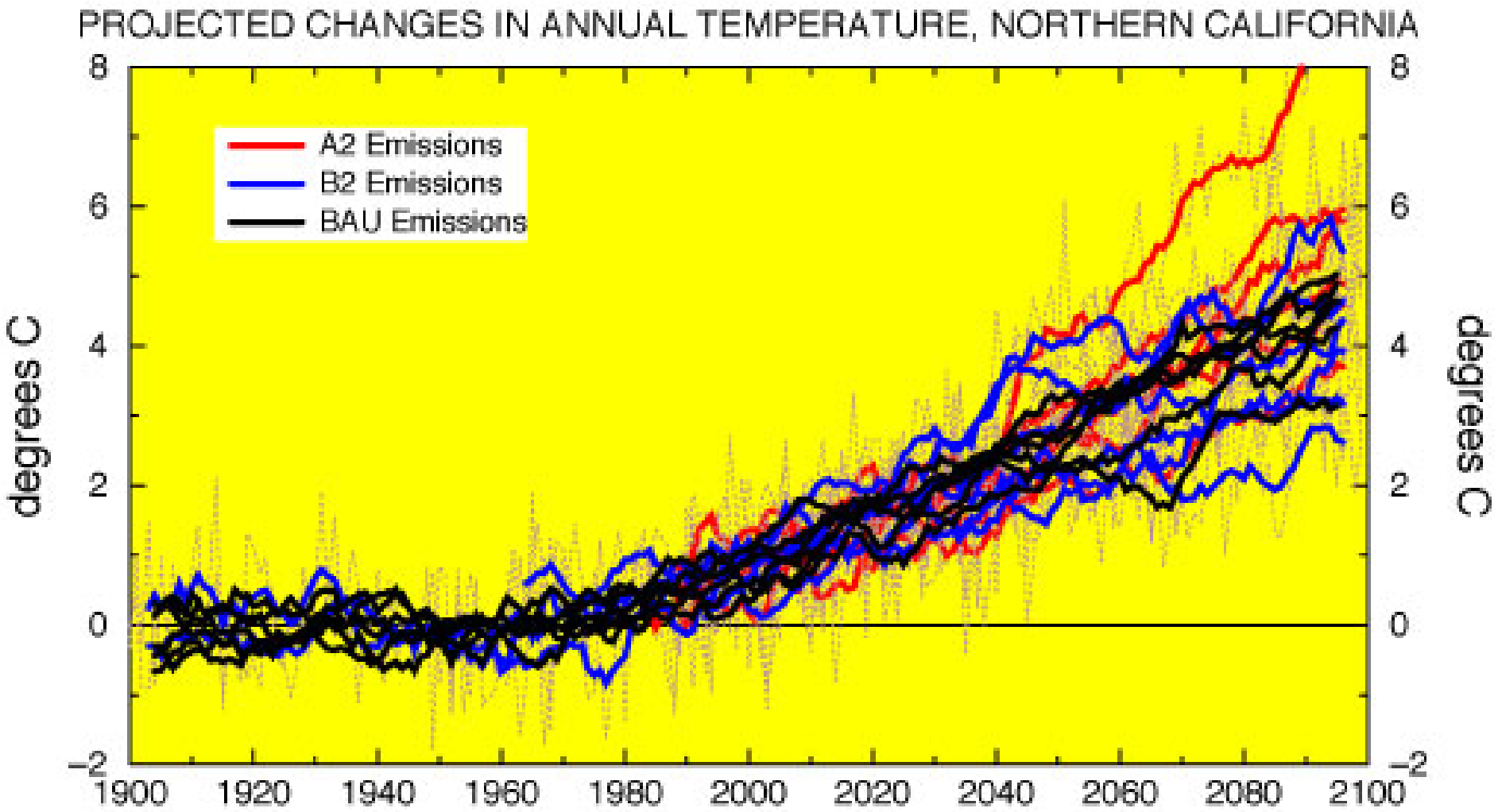
Western Regional Climate Center

DRI Desert Research Institute

Powered by ACIS NOAA Regional Climate Centers

Several types of summaries
And presentations available.

Courtesy of Mike Dettinger, USGS / Scripps.



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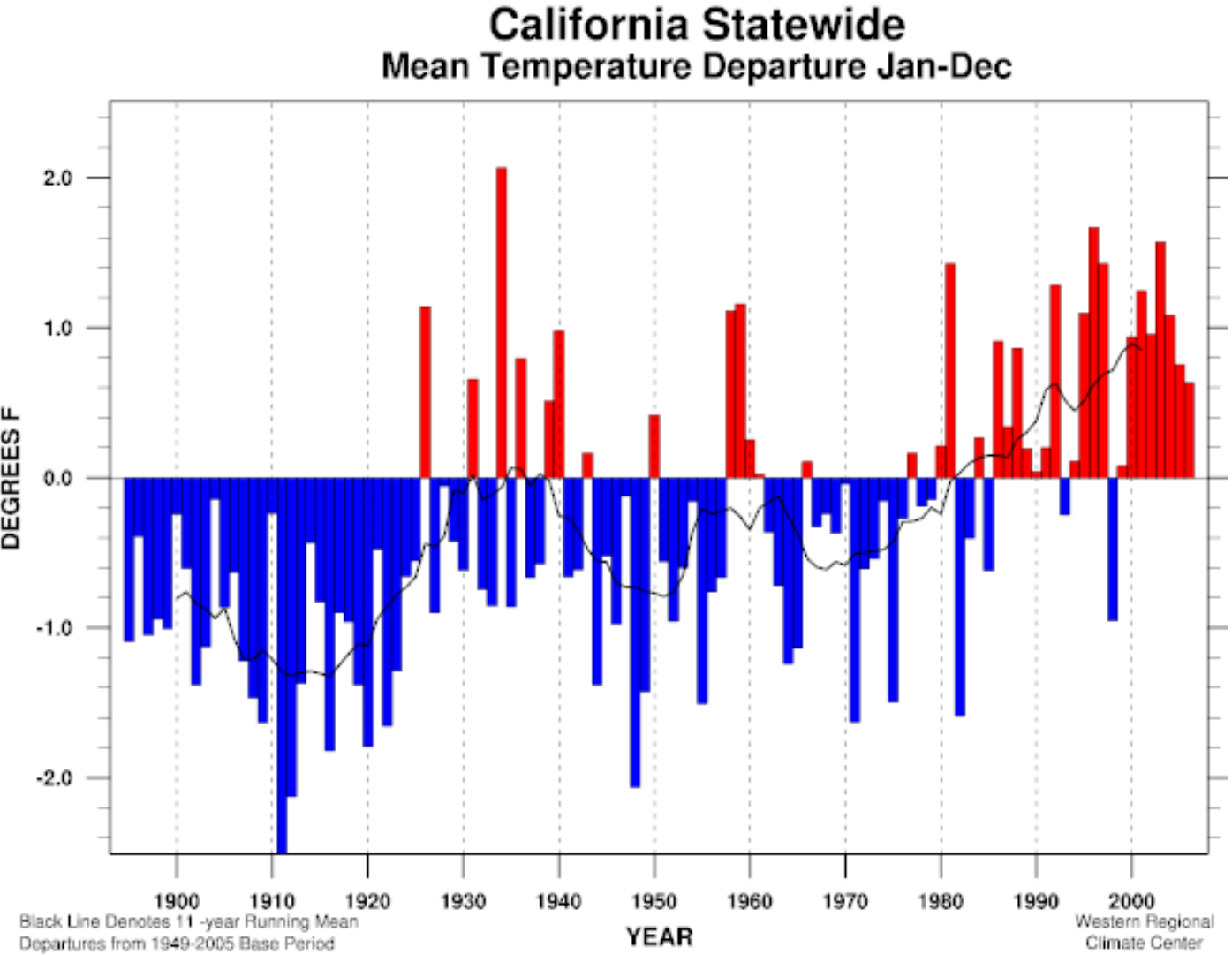
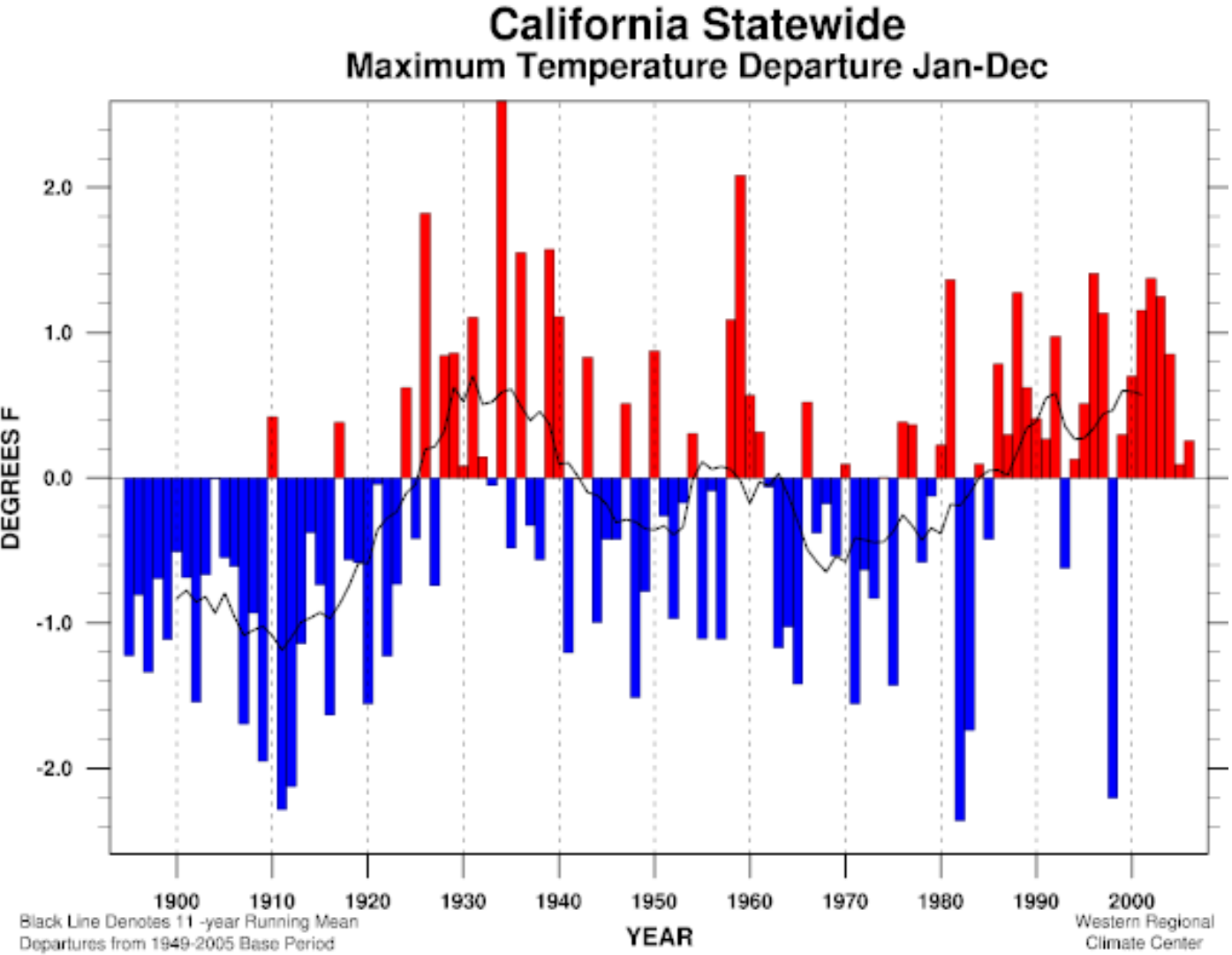


State Annual Mean Temp

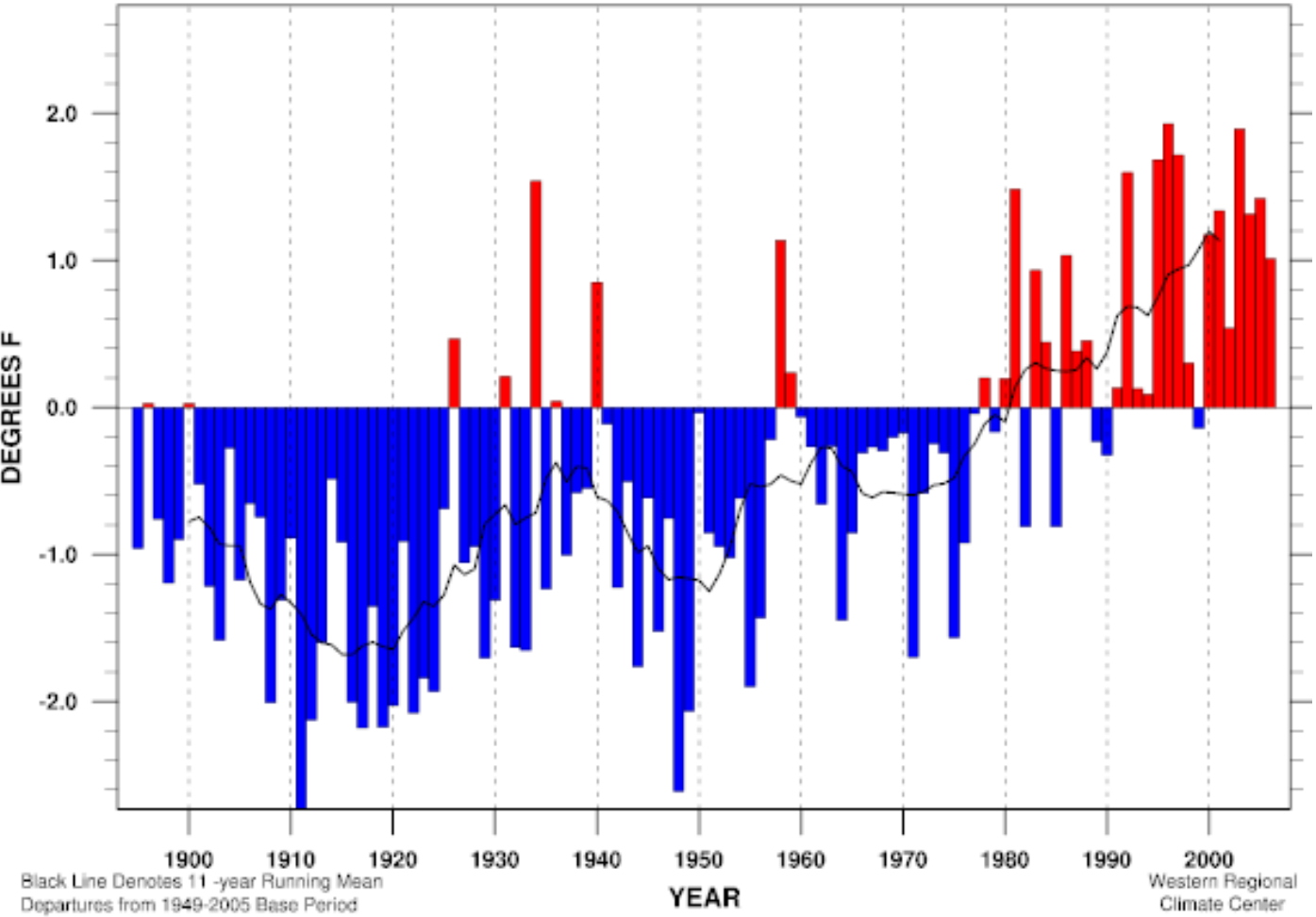
Linear Trend 1895-present		+ 1.53 ± 0.45 °F/100yr	
Linear Trend 1949-present		+ 2.79 ± 1.15 °F/100yr	
Linear Trend 1975-present		+ 4.77 ± 2.81 °F/100yr	
Warmest Year		59.5 °F (+ 2.1 °F) in 1934	MEAN 57.5 °F
Coldest Year		54.9 °F (- 2.5 °F) in 1911	STDEV 0.87 °F
Jan-Dec	2006	58.1 °F (+ 0.6 °F)	RANK 92 of 112



State
Annual
Mean Max Temp

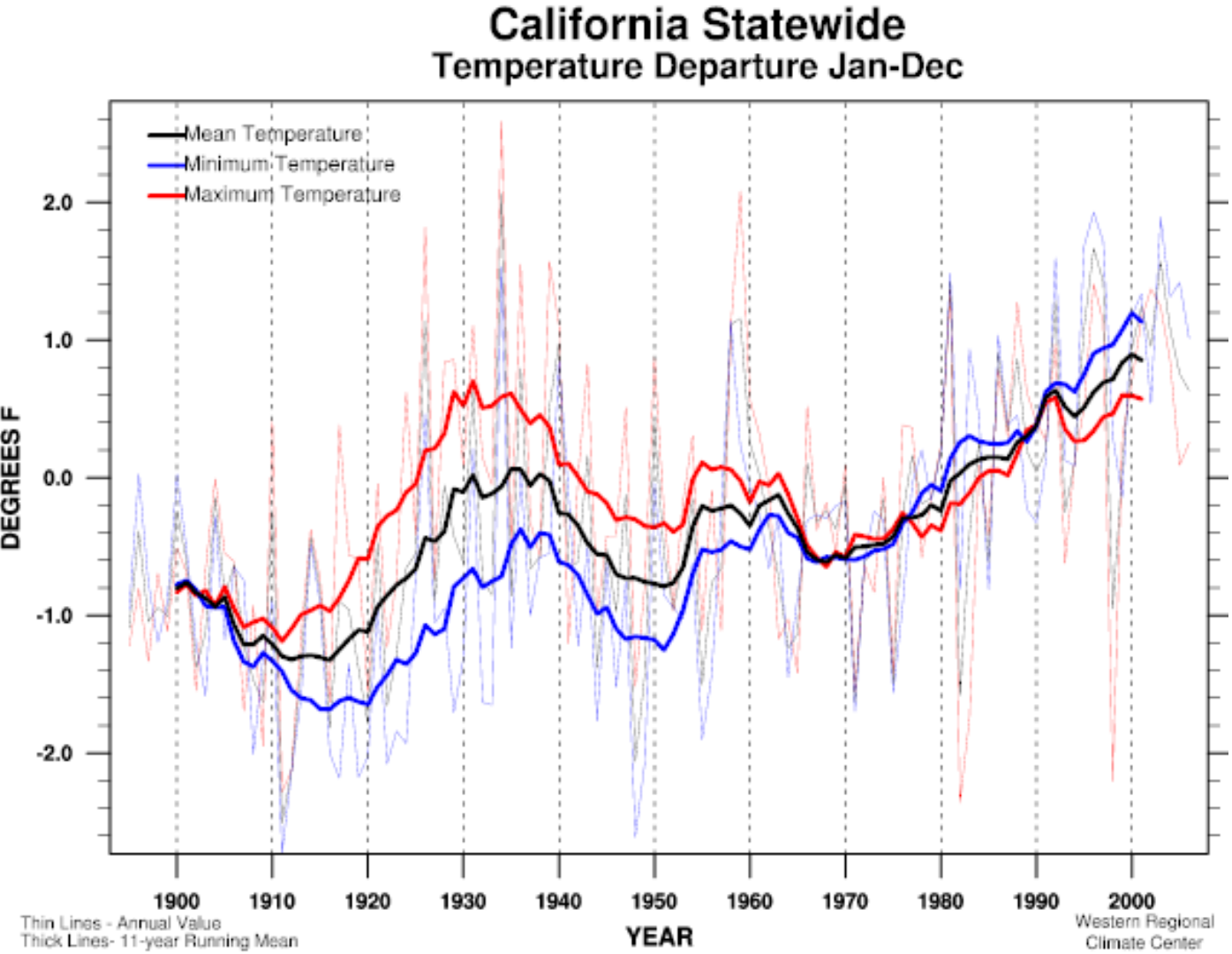
Linear Trend 1895-present		+ 1.04 ± 0.55 °F/100yr	
Linear Trend 1949-present		+ 1.60 ± 1.44 °F/100yr	
Linear Trend 1975-present		+ 3.73 ± 3.69 °F/100yr	
Warmest Year		73.2 °F (+ 2.6 °F) in 1934	MEAN 70.7 °F
Coldest Year		68.3 °F (- 2.4 °F) in 1982	STDEV 0.95 °F
Jan-Dec	2006	70.9 °F (+ 0.3 °F)	RANK 73 of 112

California Statewide
Miniumum Temperature Departure Jan-Dec



State Annual Mean Min Temp

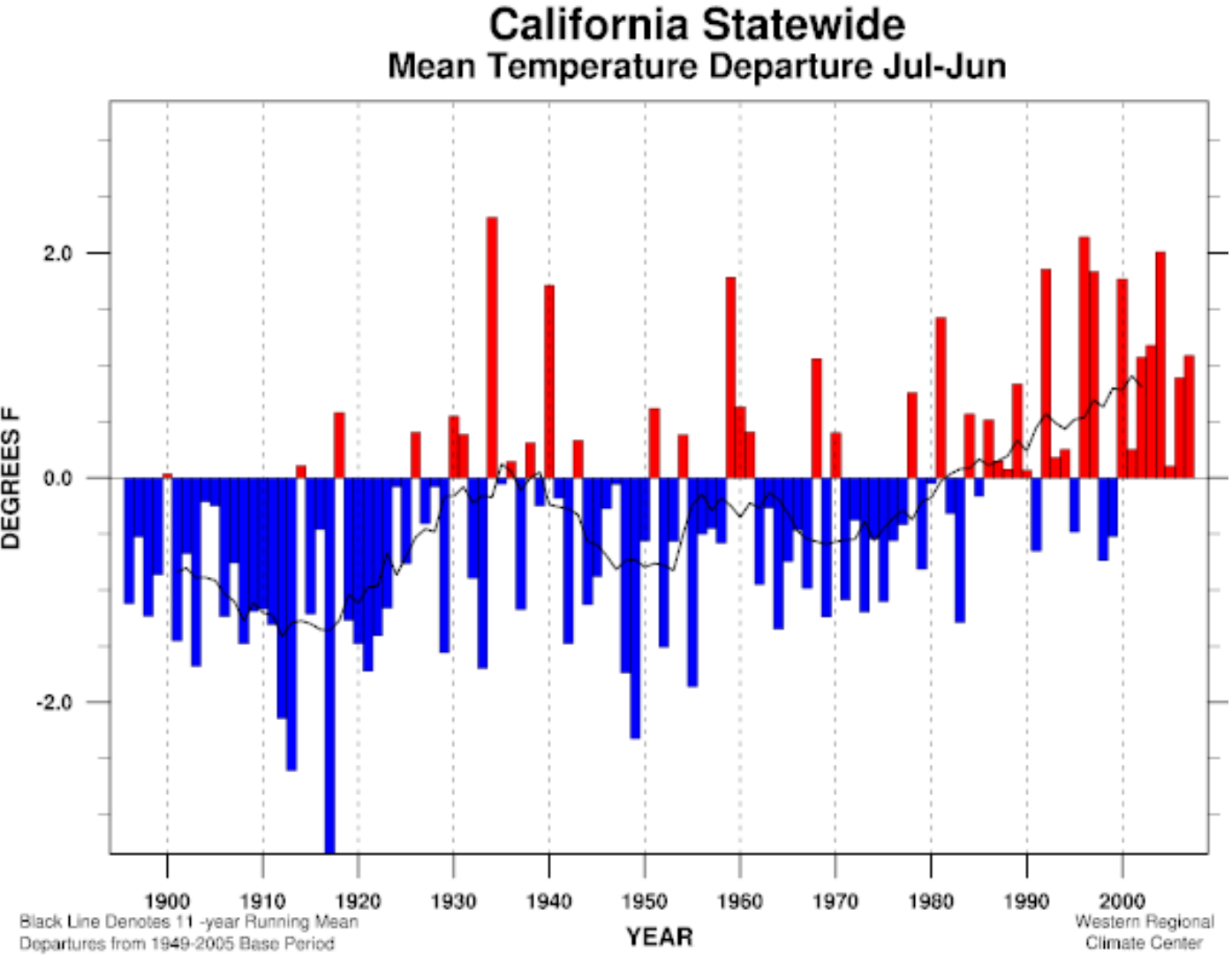
Linear Trend 1895-present		+ 2.02 ± 0.48 °F/100yr	
Linear Trend 1949-present		+ 3.98 ± 1.13 °F/100yr	
Linear Trend 1975-present		+ 5.81 ± 2.84 °F/100yr	
Warmest Year		46.2 °F (+ 1.9 °F) in 1996	MEAN 44.3 °F
Coldest Year		41.5 °F (- 2.7 °F) in 1911	STDEV 0.98 °F
Jan-Dec	2006	45.3 °F (+ 1.0 °F)	RANK 99 of 112



	Maximum Temperature	Minimum Temperature
Linear Trend 1895-present	+ 1.04 (± 0.55) °F/100yr	+ 2.02 (± 0.48) °F/100yr
Linear Trend 1949-present	+ 1.60 (± 1.44) °F/100yr	+ 3.98 (± 1.13) °F/100yr
Linear Trend 1975-present	+ 3.73 (± 3.69) °F/100yr	+ 5.81 (± 2.84) °F/100yr

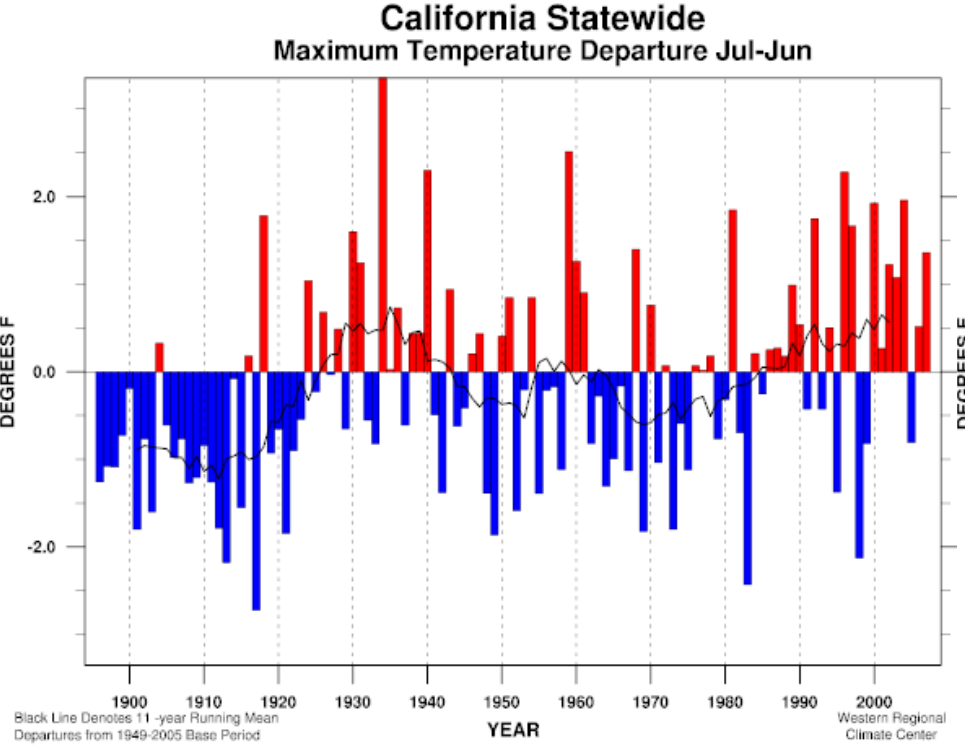
State Annual Temperature Summary

(Max, Mean, Min)

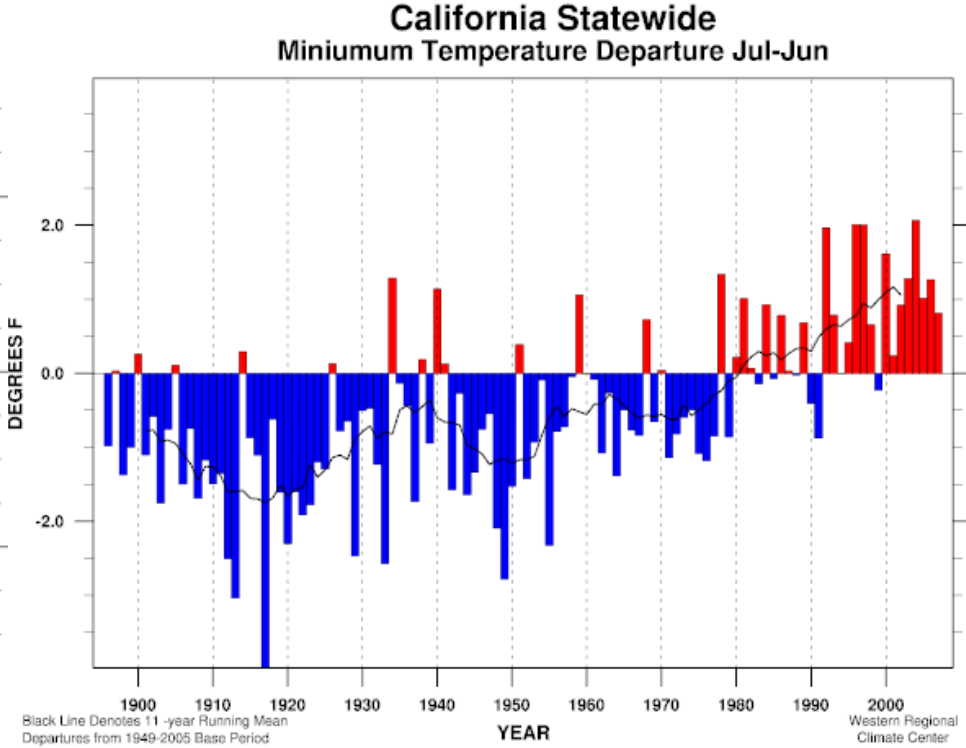


Statewide 12-Month Winter-Centered Year (July-June)

Linear Trend 1895-present		+ 1.57 ± 0.53 °F/100yr	
Linear Trend 1949-present		+ 2.69 ± 1.37 °F/100yr	
Linear Trend 1975-present		+ 4.21 ± 3.29 °F/100yr	
Warmest Year		59.8 °F (+ 2.3 °F) in 1934	MEAN 57.5 °F
Coldest Year		54.1 °F (- 3.4 °F) in 1917	STDEV 0.98 °F
Jul-Jun	2007	58.6 °F (+ 1.1 °F)	RANK 102 of 112



Linear Trend 1895-present	+ 1.09 ± 0.64 °F/100yr		
Linear Trend 1949-present	+ 1.58 ± 1.78 °F/100yr		
Linear Trend 1975-present	+ 3.42 ± 4.40 °F/100yr		
Warmest Year	74.0 °F (+ 3.4 °F) in 1934	MEAN	70.7 °F
Coldest Year	67.9 °F (- 2.7 °F) in 1917	STDEV	1.16 °F
Jul-Jun 2007	72.0 °F (+ 1.4 °F)	RANK	100 of 112

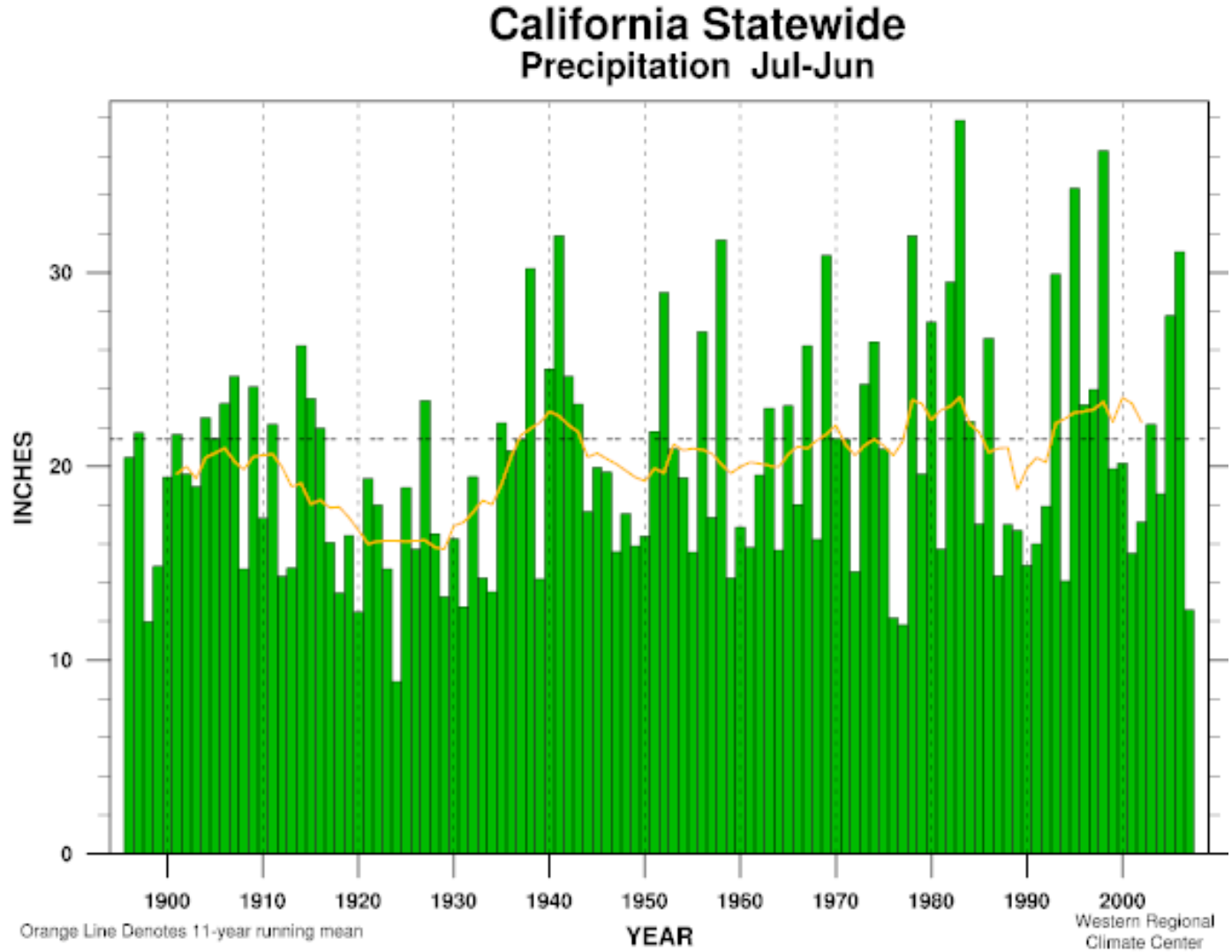


Linear Trend 1895-present	+ 2.05 ± 0.54 °F/100yr		
Linear Trend 1949-present	+ 3.80 ± 1.21 °F/100yr		
Linear Trend 1975-present	+ 4.99 ± 3.03 °F/100yr		
Warmest Year	46.3 °F (+ 2.1 °F) in 2004	MEAN	44.3 °F
Coldest Year	40.3 °F (- 4.0 °F) in 1917	STDEV	1.00 °F
Jul-Jun 2007	45.1 °F (+ 0.8 °F)	RANK	97 of 112

Statewide
Winter-Centered July-June

Mean Max Temperature

Mean Min Temperature

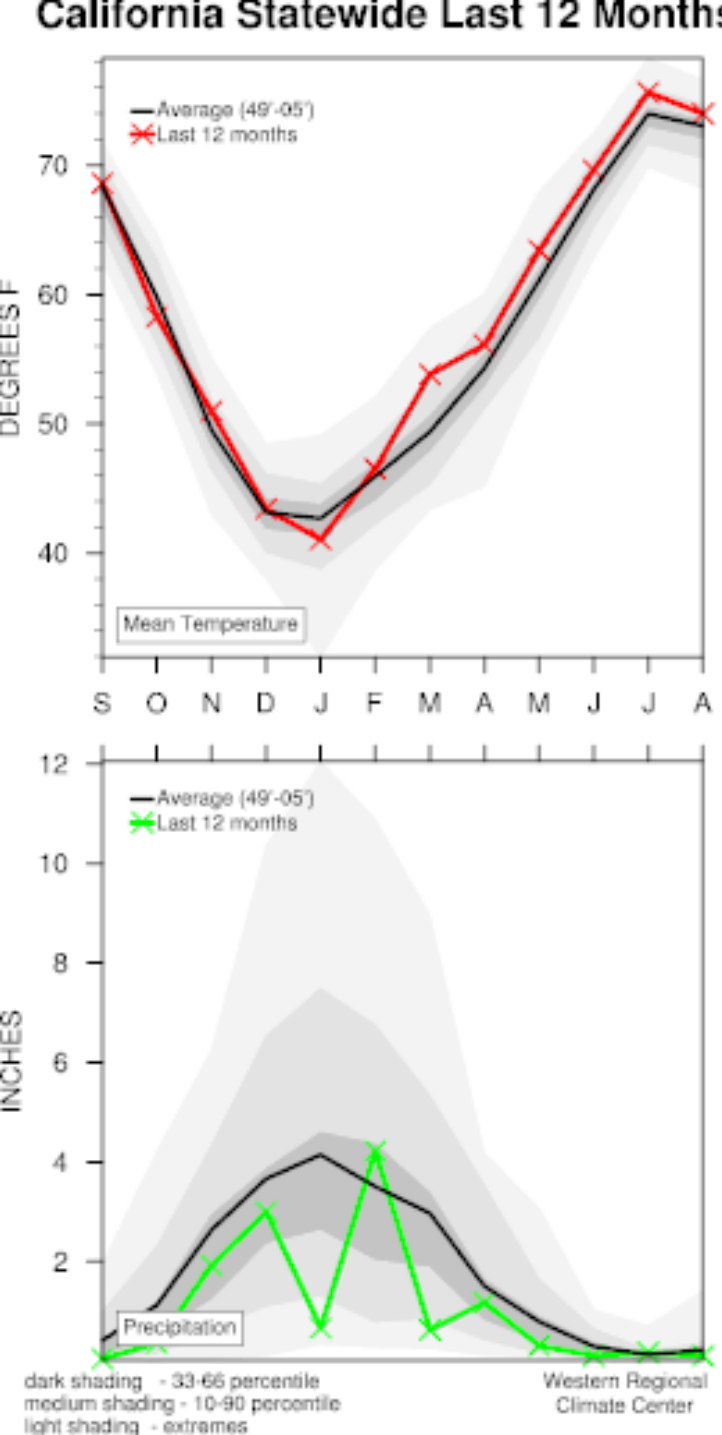


Linear Trend 1895-present	+ 3.84 ± 3.27 in.	(+ 17 ± 15%) per 100 yr	
Linear Trend 1949-present	+ 2.84 ± 10.18 in.	(+ 13 ± 47%) per 100 yr	
Linear Trend 1975-present	+ 3.56 ± 29.46 in.	(+ 16 ± 137%) per 100 yr	
Wettest Year	37.84 in. (176%)	in 1983	MEAN 21.41in.
Driest Year	8.88 in. (41%)	in 1924	STDEV 6.39 in.
Jul-Jun 2007	12.57 in. (58%)		RANK 6 of 112

Is California in drought ???

Frequent question from the US Drought Monitor

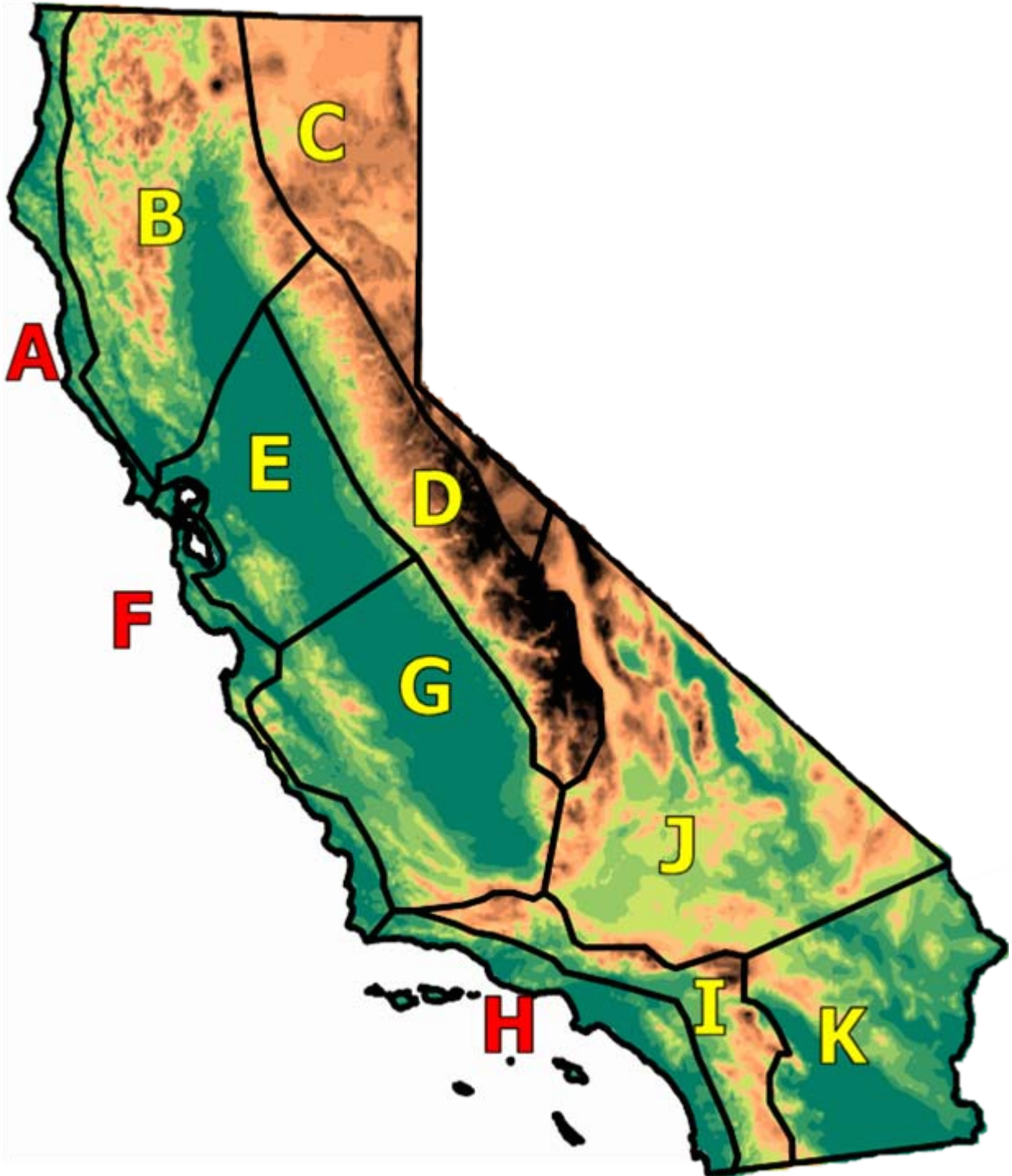
Statewide Winter-Centered July-June Precipitation



Quick monthly recap of the last 12 months for the selected region, in actual units.

Temperature

Precipitation


A
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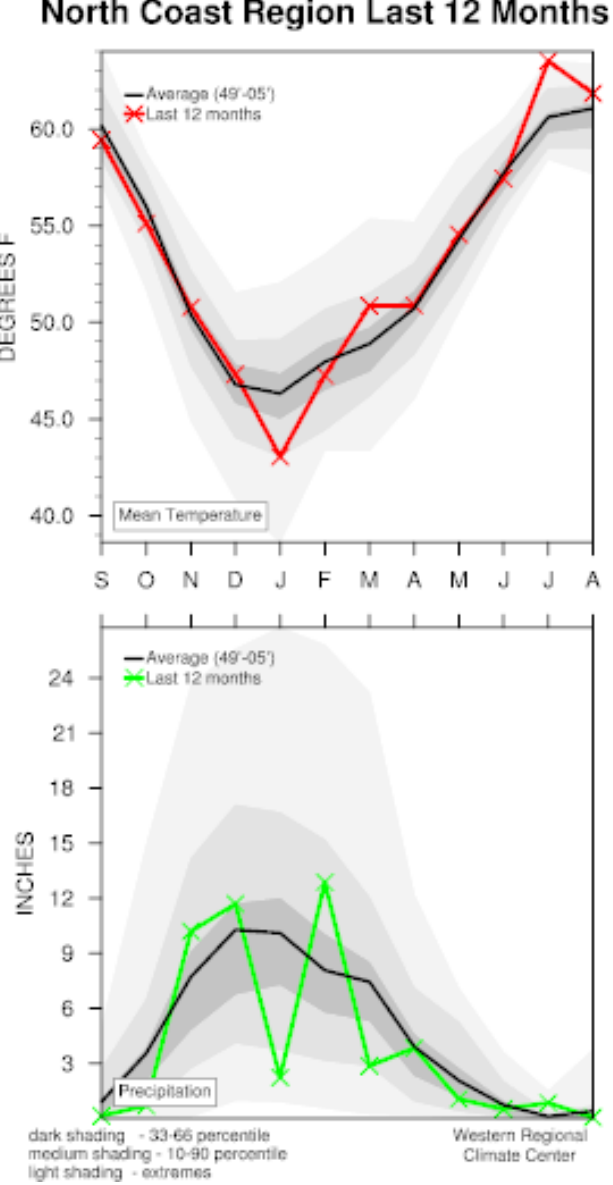
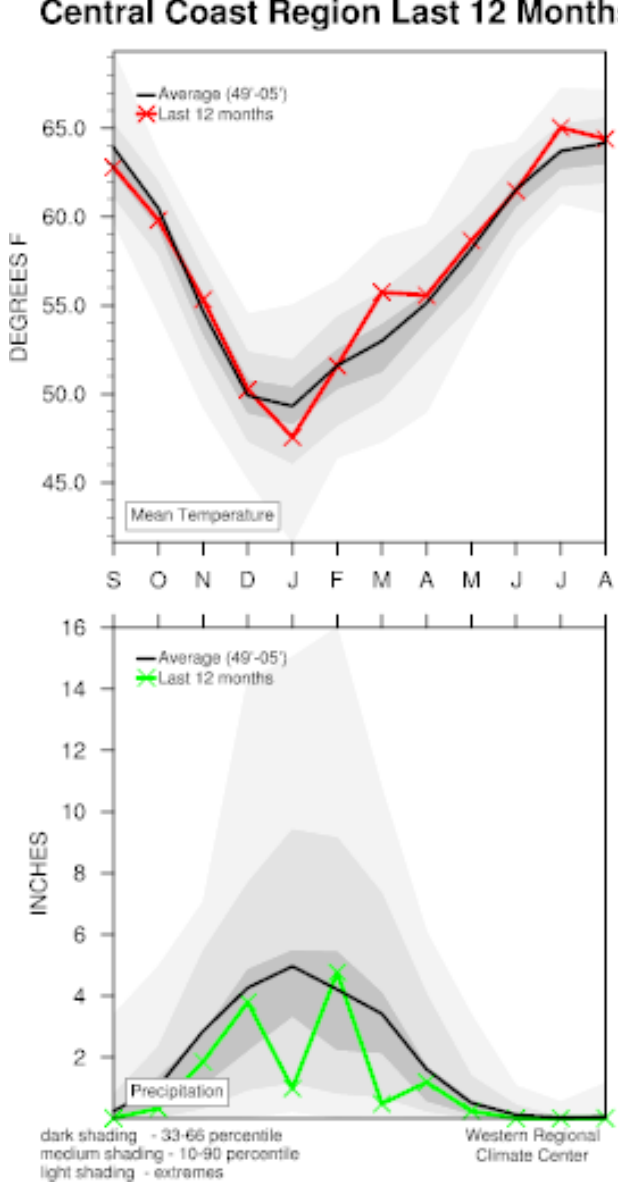
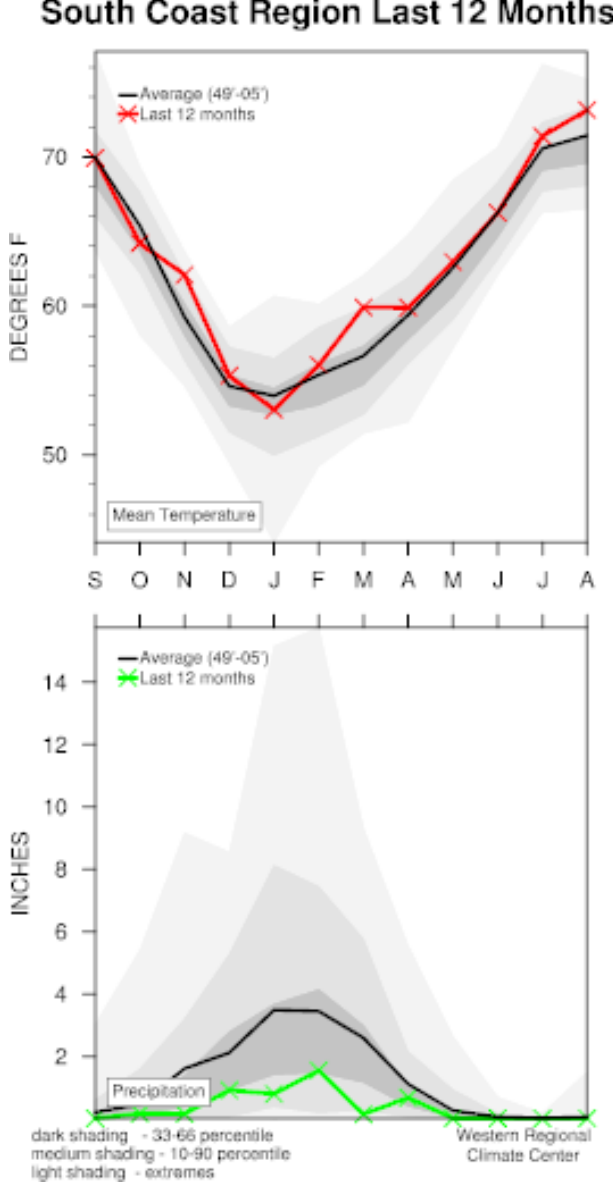




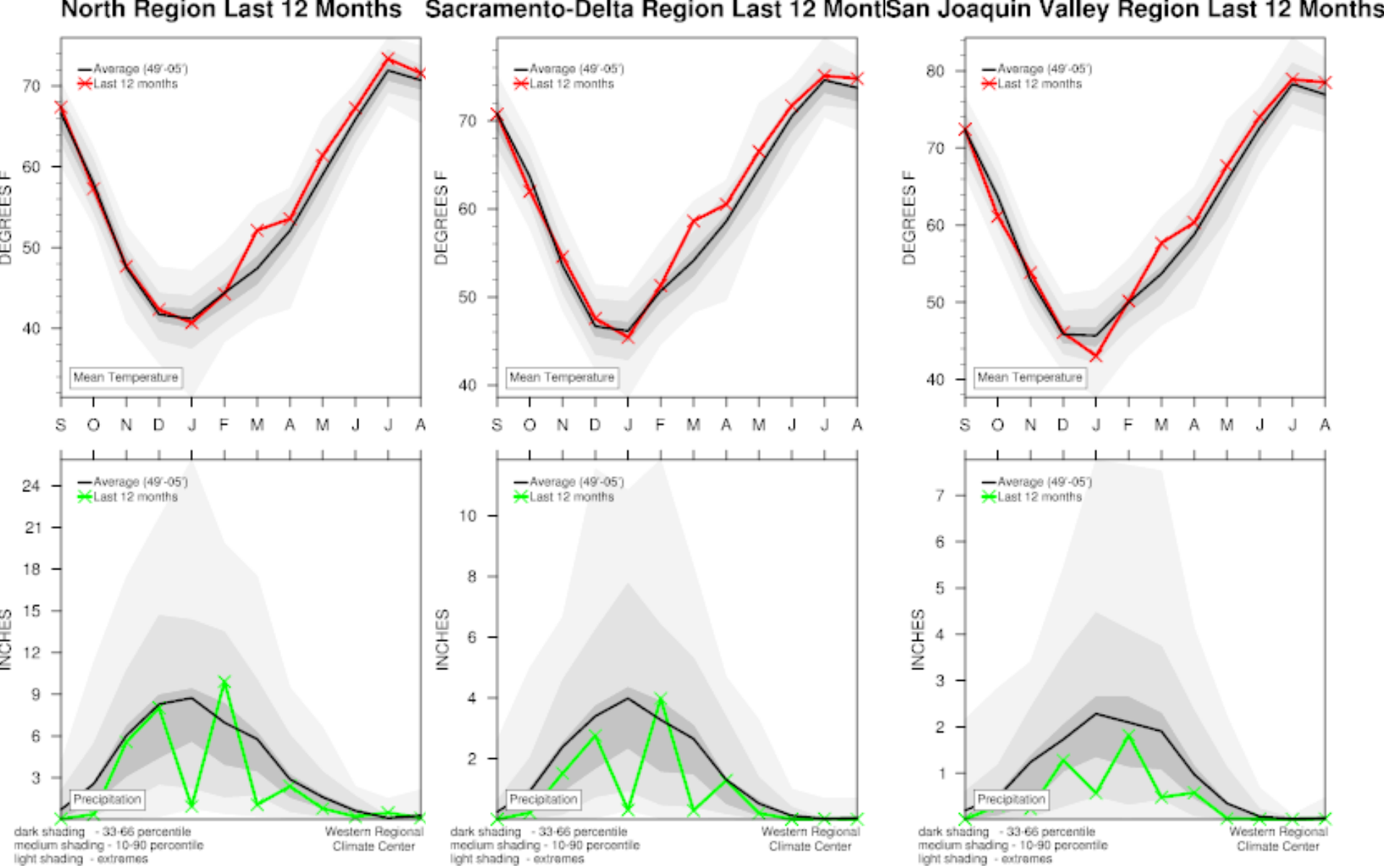


Coastal California

North

Central

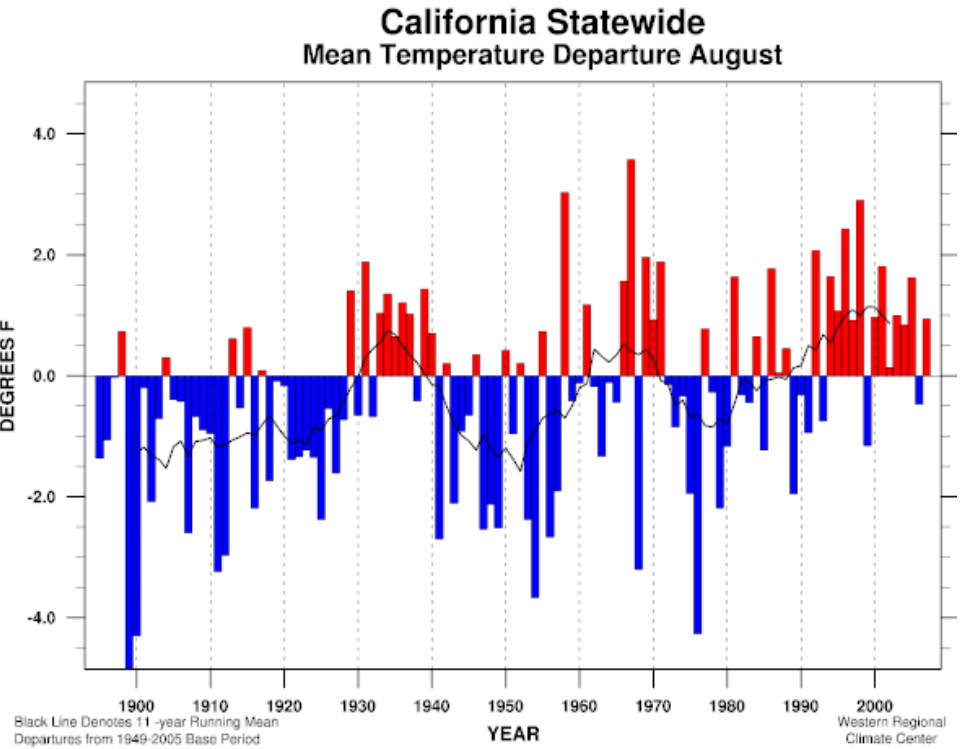
South



Interior California (I-5 Corridor)

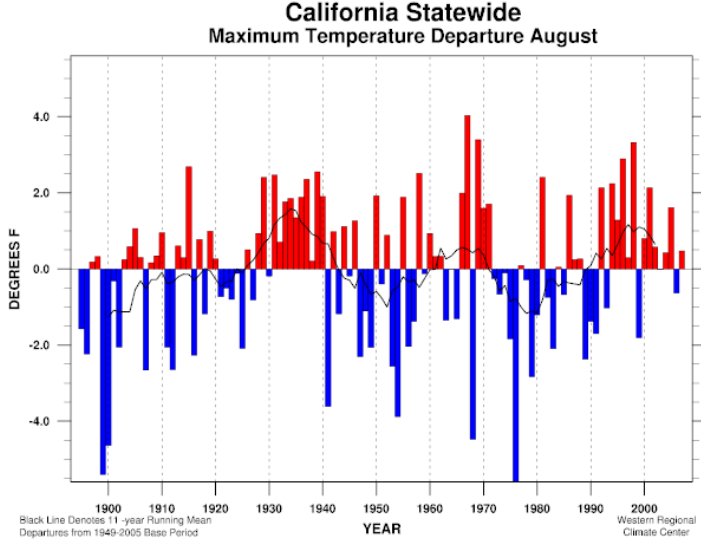
Northern / Sacramento R **Bay-Delta** **Southern / San Joaquin R**

August 2007



Linear Trend 1895-present		+ 1.70 ± 0.86 °F/100yr	
Linear Trend 1949-present		+ 3.08 ± 2.44 °F/100yr	
Linear Trend 1975-present		+ 7.80 ± 5.04 °F/100yr	
Warmest Year		76.6 °F (+ 3.6 °F) in 1967	MEAN 73.1 °F
Coldest Year		68.2 °F (- 4.9 °F) in 1899	STDEV 1.68 °F
August	2007	74.0 °F (+ 0.9 °F)	RANK 89 of 113

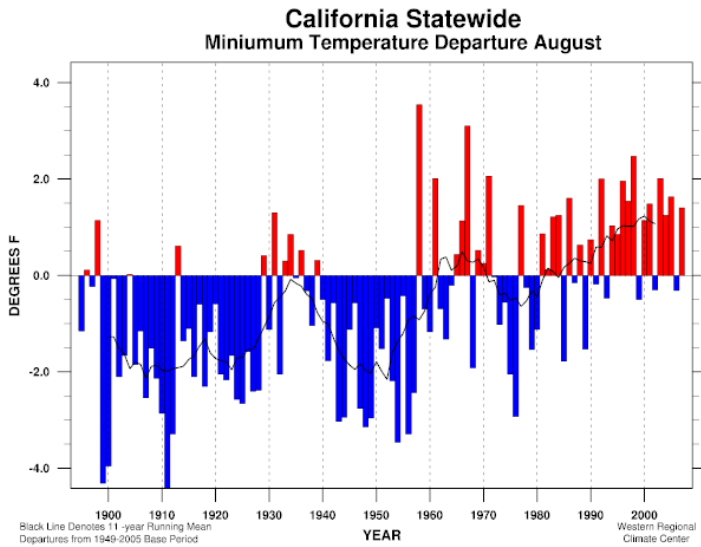
Max



Linear Trend 1895-present		+ 0.84 ± 1.06 °F/100yr	
Linear Trend 1949-present		+ 1.83 ± 2.98 °F/100yr	
Linear Trend 1975-present		+ 8.64 ± 6.38 °F/100yr	
Warmest Year		92.7 °F (+ 4.0 °F) in 1967	MEAN 88.7 °F
Coldest Year		83.1 °F (- 5.6 °F) in 1976	STDEV 1.97 °F
August	2007	89.1 °F (+ 0.5 °F)	RANK 70 of 113

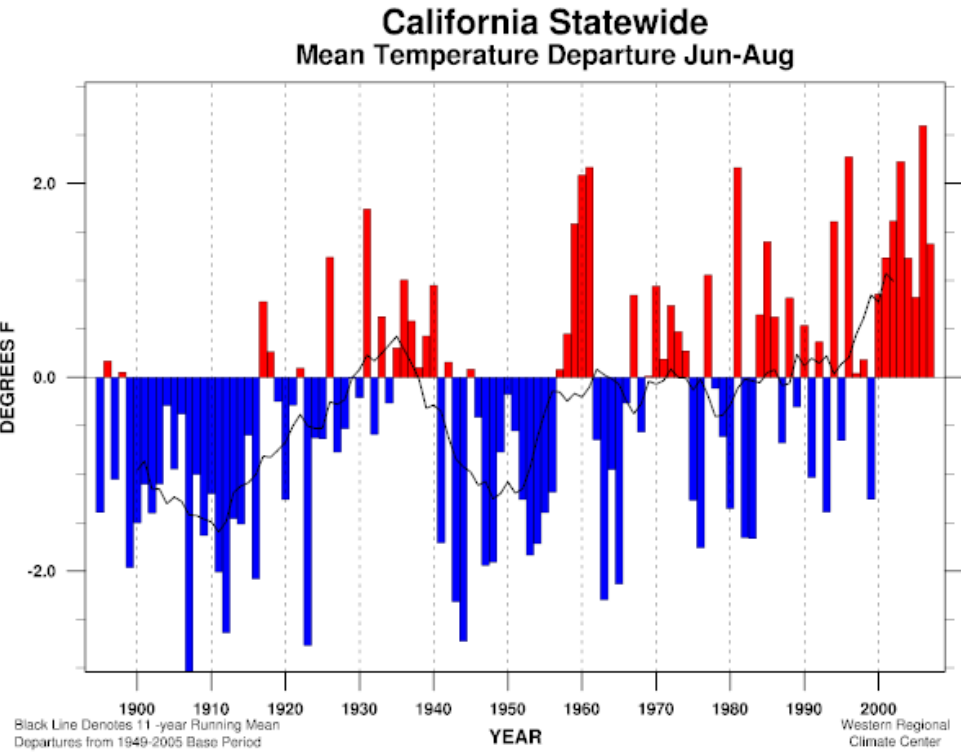
Mean

Min



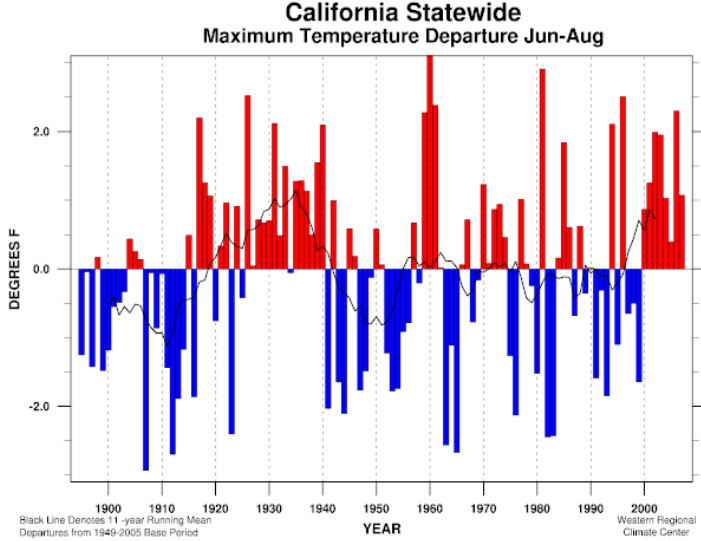
Linear Trend 1895-present		+ 2.56 ± 0.82 °F/100yr	
Linear Trend 1949-present		+ 4.32 ± 2.21 °F/100yr	
Linear Trend 1975-present		+ 6.97 ± 4.42 °F/100yr	
Warmest Year		61.0 °F (+ 3.5 °F) in 1958	MEAN 57.5 °F
Coldest Year		53.0 °F (- 4.4 °F) in 1911	STDEV 1.62 °F
August	2007	58.9 °F (+ 1.4 °F)	RANK 100 of 113

Summer 2007 (Jun-Jul-Aug)



Linear Trend 1895-present		+ 1.64 ± 0.65 °F/100yr	
Linear Trend 1949-present		+ 2.94 ± 1.79 °F/100yr	
Linear Trend 1975-present		+ 6.74 ± 4.19 °F/100yr	
Warmest Year		74.3 °F (+ 2.6 °F) in 2006	MEAN 71.7 °F
Coldest Year		68.7 °F (- 3.0 °F) in 1907	STDEV 1.27 °F
Jun-Aug	2007	73.1 °F (+ 1.4 °F)	RANK 102 of 113

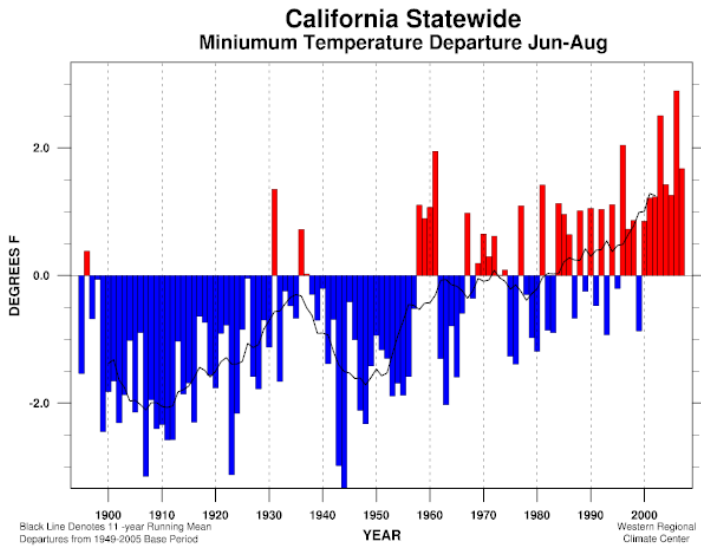
Max



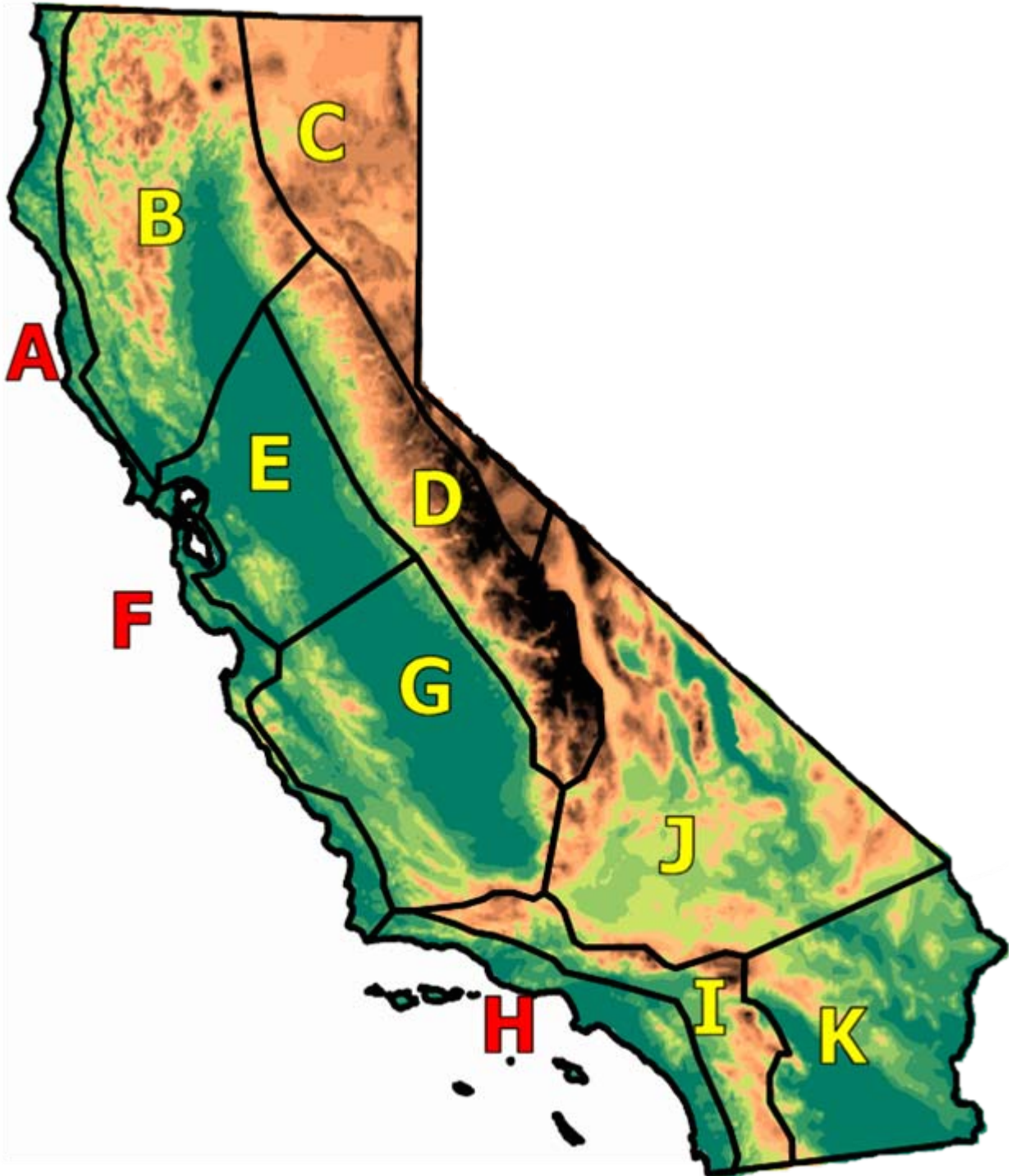
Linear Trend 1895-present		+ 0.69 ± 0.79 °F/100yr	
Linear Trend 1949-present		+ 1.71 ± 2.20 °F/100yr	
Linear Trend 1975-present		+ 6.06 ± 5.26 °F/100yr	
Warmest Year		90.2 °F (+ 3.1 °F) in 1960	MEAN 87.1 °F
Coldest Year		84.2 °F (- 2.9 °F) in 1907	STDEV 1.47 °F
Jun-Aug	2007	88.2 °F (+ 1.1 °F)	RANK 91 of 113

Mean

Min



Linear Trend 1895-present		+ 2.59 ± 0.59 °F/100yr	
Linear Trend 1949-present		+ 4.18 ± 1.52 °F/100yr	
Linear Trend 1975-present		+ 7.43 ± 3.41 °F/100yr	
Warmest Year		59.3 °F (+ 2.9 °F) in 2006	MEAN 56.4 °F
Coldest Year		53.0 °F (- 3.3 °F) in 1944	STDEV 1.22 °F
Jun-Aug	2007	58.0 °F (+ 1.7 °F)	RANK 109 of 113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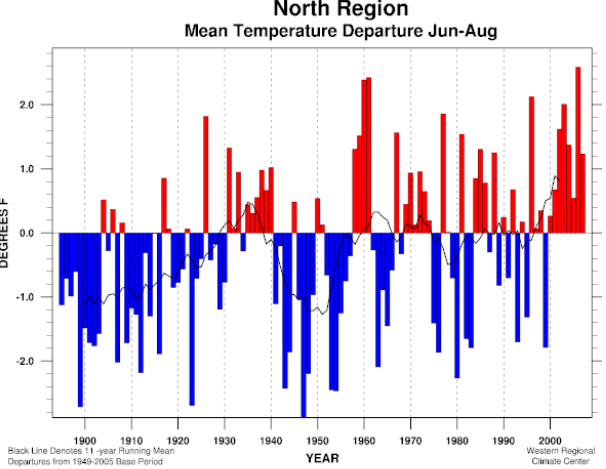
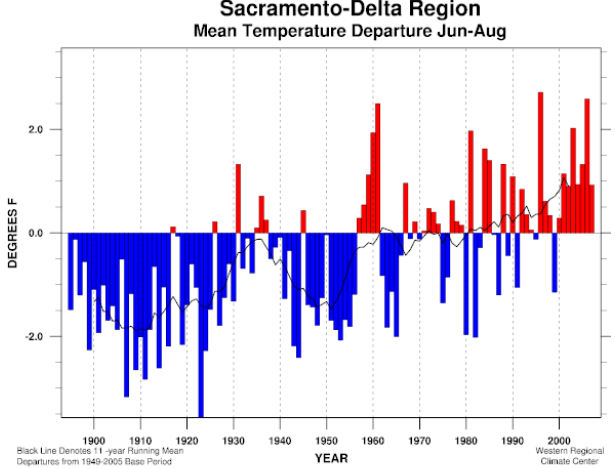
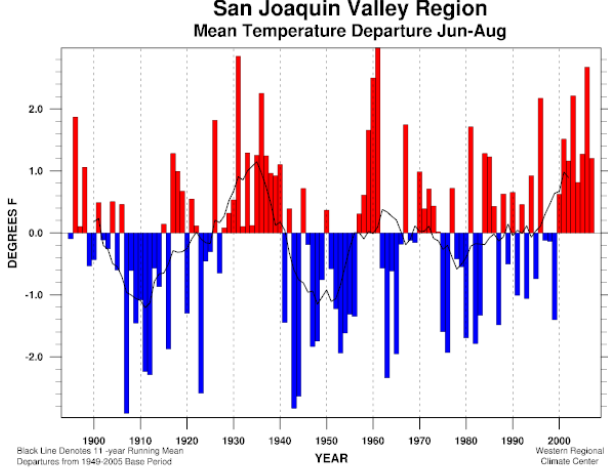




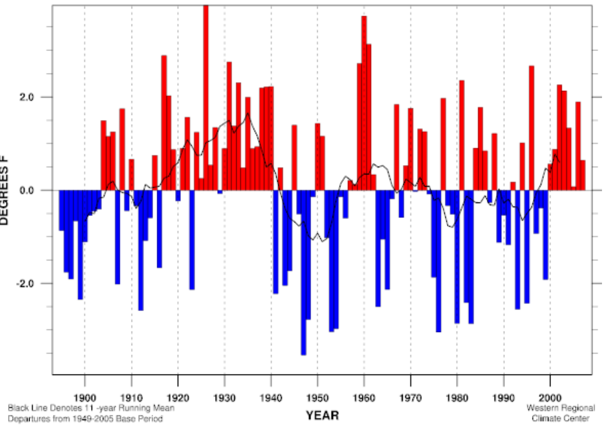


Interior California (I-5 Corridor)
Mean Summer Temperature

Northern / Sacramento R **Bay-Delta** **Southern / San Joaquin R**

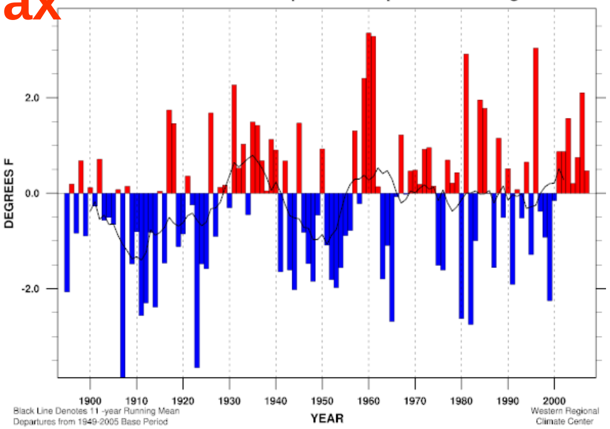
Max

North Region
Maximum Temperature Departure Jun-Aug



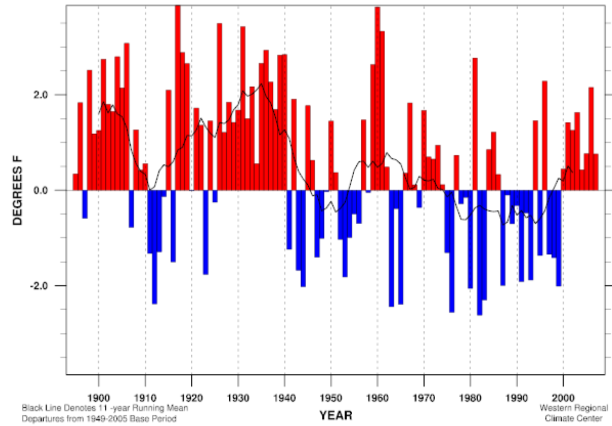
Linear Trend 1895-present	+ 0.13 ± 0.97 °F/100yr		
Linear Trend 1949-present	+ 0.76 ± 2.64 °F/100yr		
Linear Trend 1975-present	+ 6.32 ± 6.10 °F/100yr		
Warmest Year	90.5 °F (+ 4.0 °F) in 1926	MEAN	86.5 °F
Coldest Year	83.0 °F (- 3.5 °F) in 1947	STDEV	1.73 °F
Jun-Aug 2007	87.2 °F (+ 0.6 °F)	RANK	66 of 113

Sacramento-Delta Region
Maximum Temperature Departure Jun-Aug



Linear Trend 1895-present	+ 0.90 ± 0.80 °F/100yr		
Linear Trend 1949-present	+ 1.03 ± 2.28 °F/100yr		
Linear Trend 1975-present	+ 3.81 ± 5.46 °F/100yr		
Warmest Year	92.7 °F (+ 3.4 °F) in 1960	MEAN	89.4 °F
Coldest Year	85.5 °F (- 3.9 °F) in 1907	STDEV	1.51 °F
Jun-Aug 2007	89.8 °F (+ 0.5 °F)	RANK	76 of 113

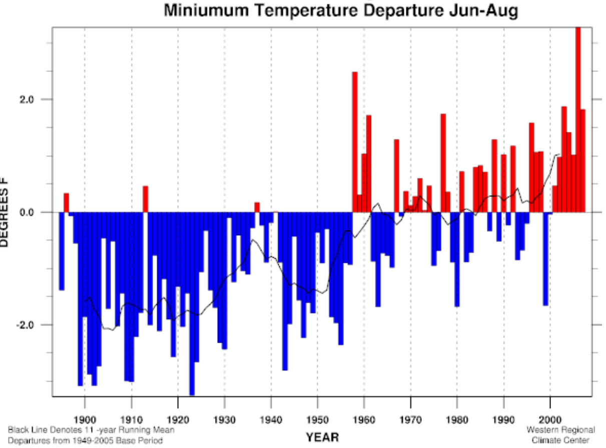
San Joaquin Valley Region
Maximum Temperature Departure Jun-Aug



Linear Trend 1895-present	- 1.49 ± 0.92 °F/100yr		
Linear Trend 1949-present	- 0.16 ± 2.39 °F/100yr		
Linear Trend 1975-present	+ 5.70 ± 5.41 °F/100yr		
Warmest Year	97.0 °F (+ 3.9 °F) in 1917	MEAN	93.1 °F
Coldest Year	90.5 °F (- 2.6 °F) in 1982	STDEV	1.56 °F
Jun-Aug 2007	93.9 °F (+ 0.8 °F)	RANK	61 of 113

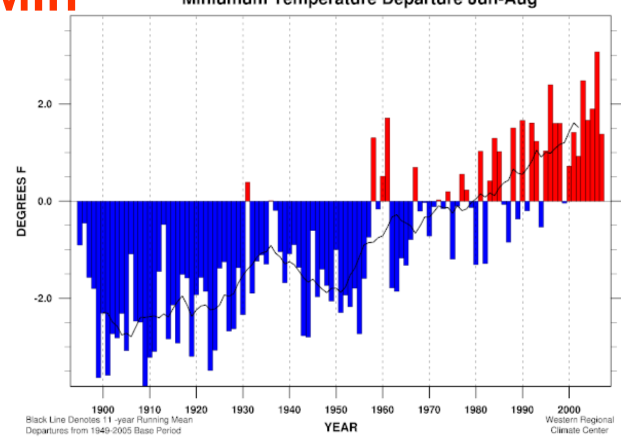
Min

North Region
Miniumum Temperature Departure Jun-Aug



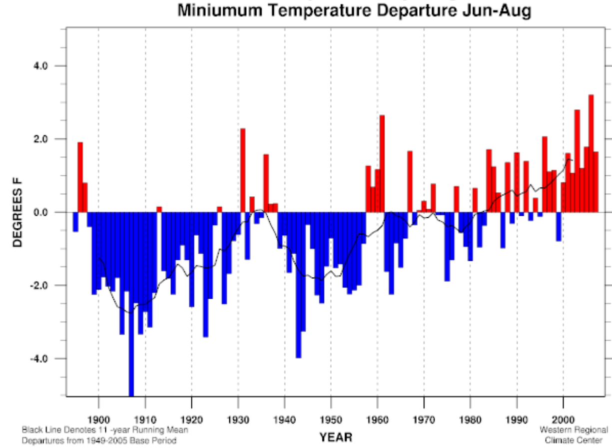
Linear Trend 1895-present	+ 2.63 ± 0.60 °F/100yr		
Linear Trend 1949-present	+ 3.27 ± 1.63 °F/100yr		
Linear Trend 1975-present	+ 5.65 ± 3.79 °F/100yr		
Warmest Year	55.8 °F (+ 3.3 °F) in 2006	MEAN	52.5 °F
Coldest Year	49.2 °F (- 3.3 °F) in 1923	STDEV	1.19 °F
Jun-Aug 2007	54.3 °F (+ 1.8 °F)	RANK	110 of 113

Sacramento-Delta Region
Miniumum Temperature Departure Jun-Aug



Linear Trend 1895-present	+ 3.70 ± 0.56 °F/100yr		
Linear Trend 1949-present	+ 5.80 ± 1.42 °F/100yr		
Linear Trend 1975-present	+ 7.45 ± 3.24 °F/100yr		
Warmest Year	59.6 °F (+ 3.1 °F) in 2006	MEAN	56.5 °F
Coldest Year	52.7 °F (- 3.8 °F) in 1909	STDEV	1.36 °F
Jun-Aug 2007	57.9 °F (+ 1.4 °F)	RANK	101 of 113

San Joaquin Valley Region
Miniumum Temperature Departure Jun-Aug



Linear Trend 1895-present	+ 2.75 ± 0.76 °F/100yr		
Linear Trend 1949-present	+ 4.82 ± 1.69 °F/100yr		
Linear Trend 1975-present	+ 8.63 ± 3.50 °F/100yr		
Warmest Year	62.0 °F (+ 3.2 °F) in 2006	MEAN	58.8 °F
Coldest Year	53.7 °F (- 5.0 °F) in 1907	STDEV	1.37 °F
Jun-Aug 2007	60.4 °F (+ 1.6 °F)	RANK	104 of 113

Interior California Summer (JJA) Max and Min Temperature

Northern / Sacramento R Bay-Delta Southern / San Joaquin R

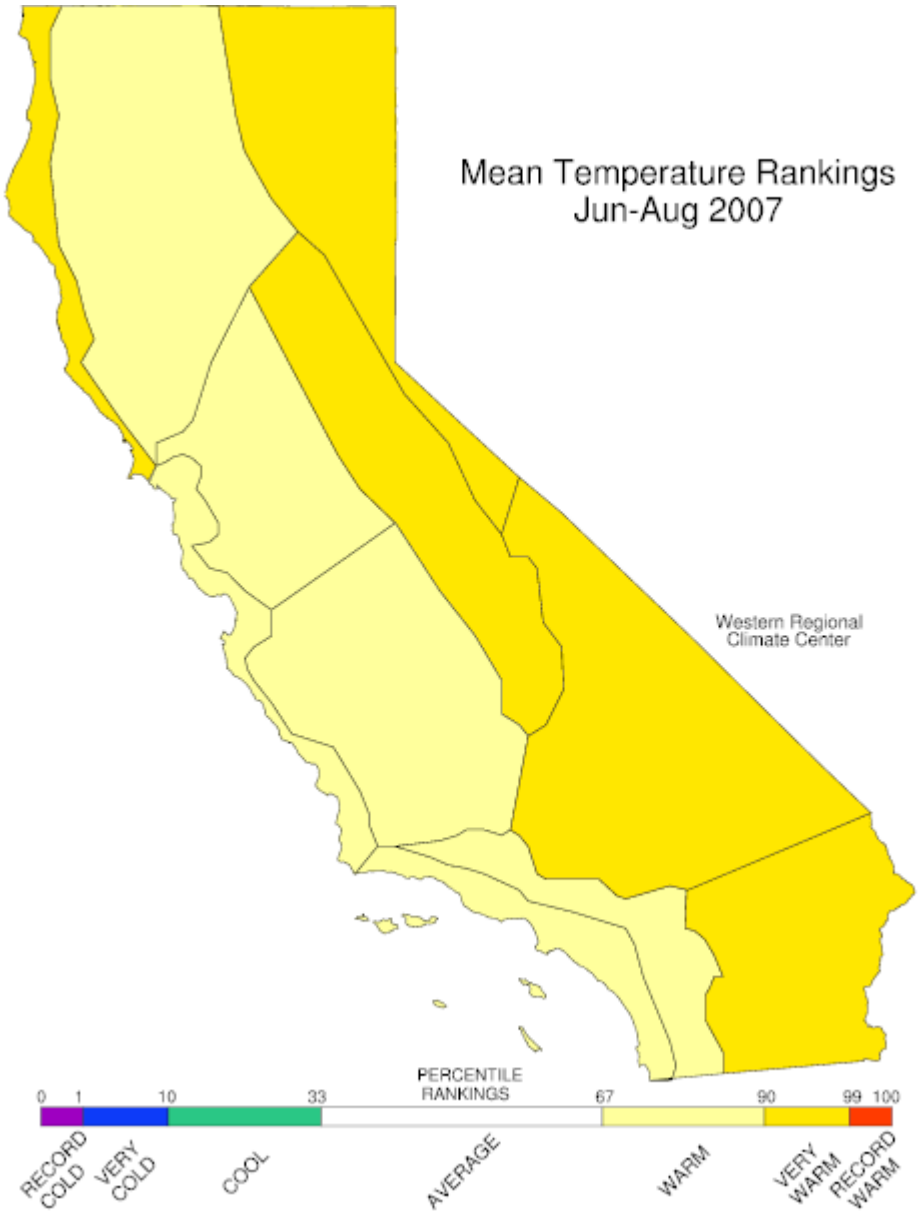
Statewide Summer JJA – 2007 Ranking

Mean T

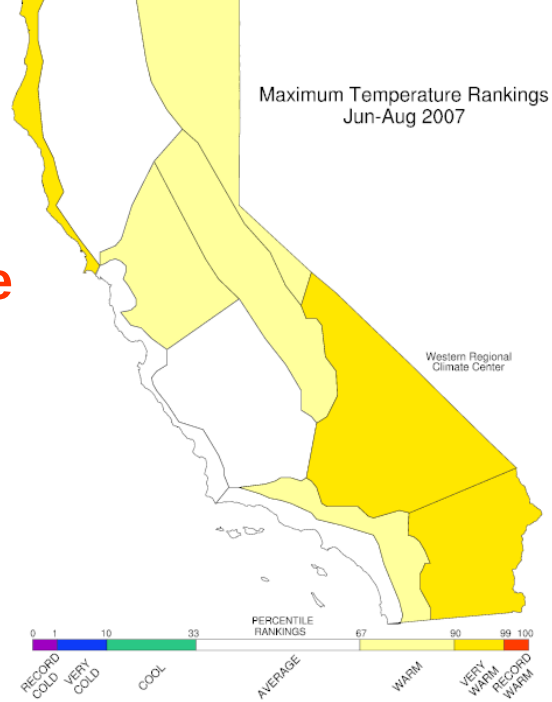
Max T

Min T

Regional Summer JJA – 2007 Temperature Rankings

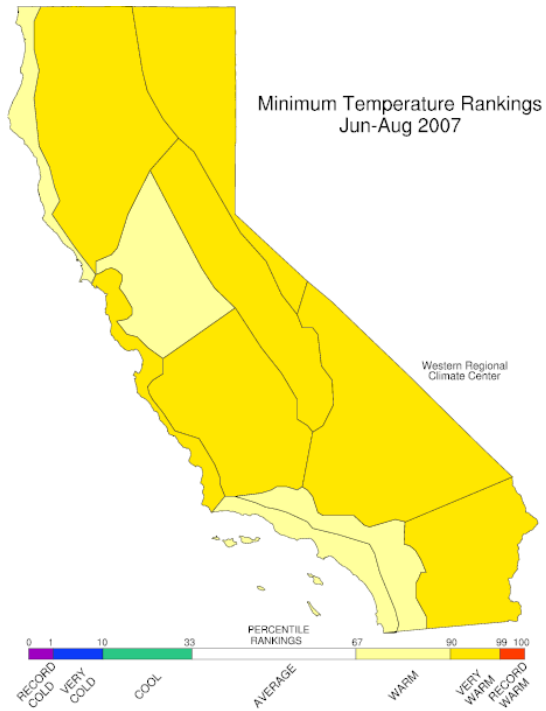


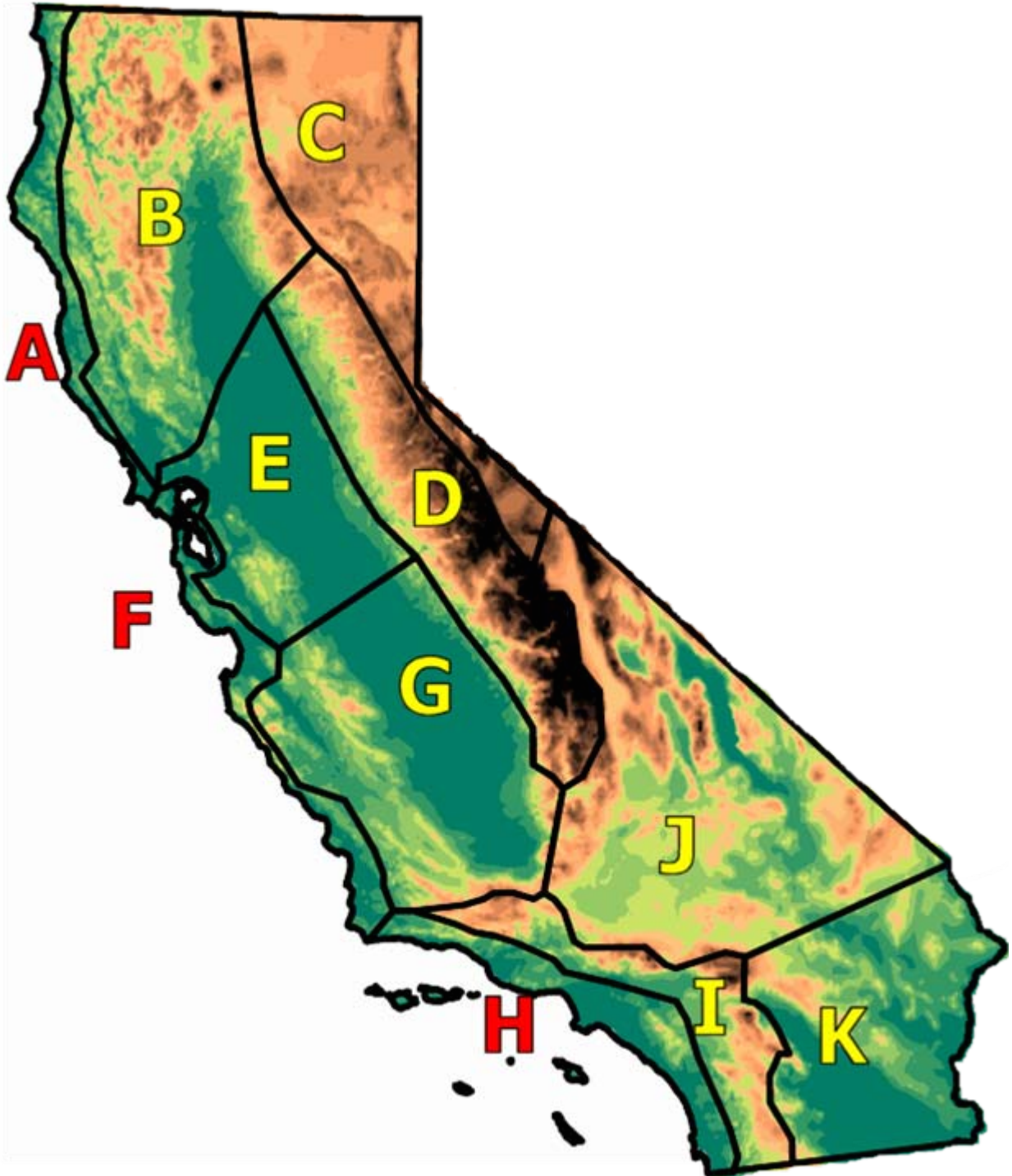
Max T



Mean T

Min T

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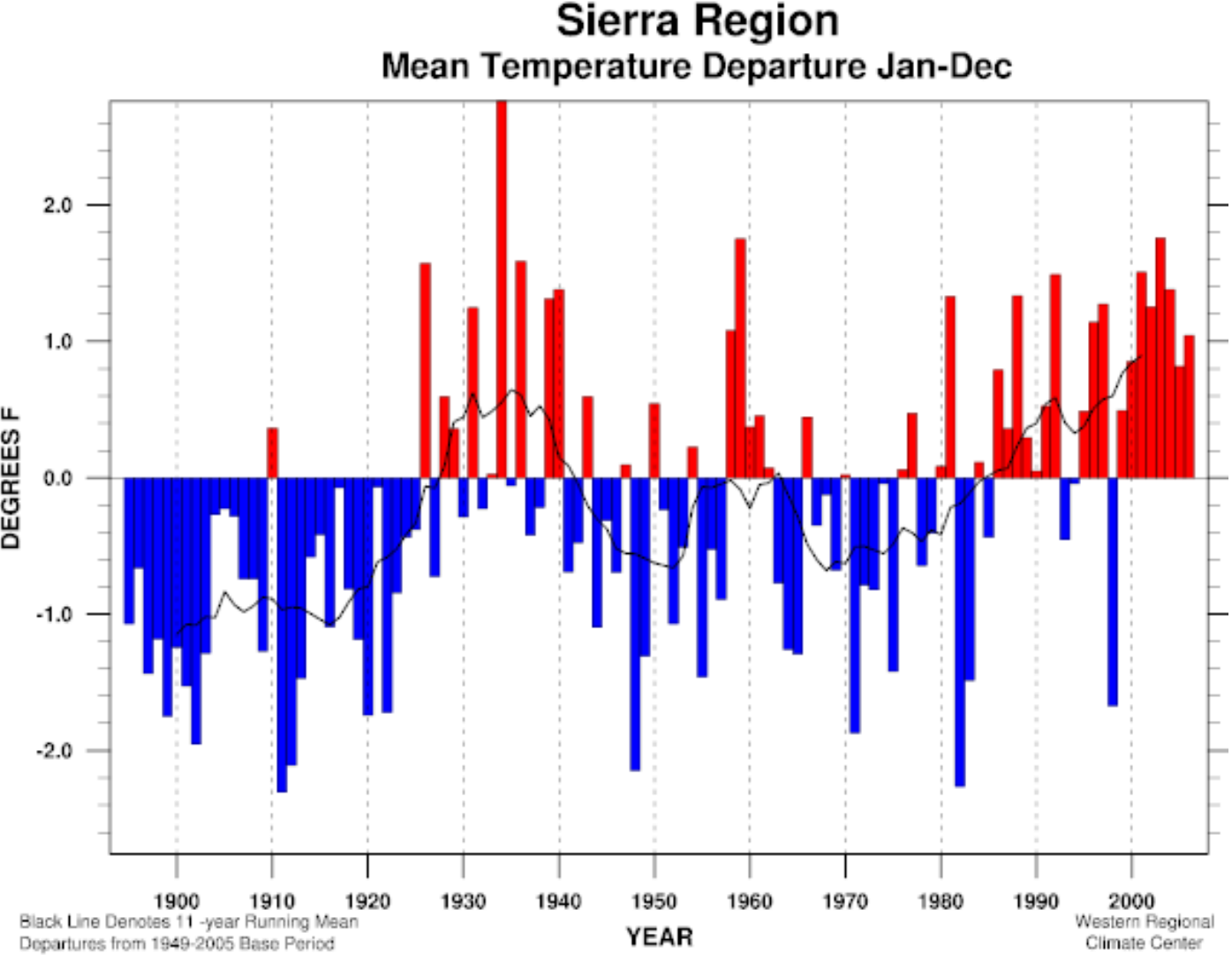


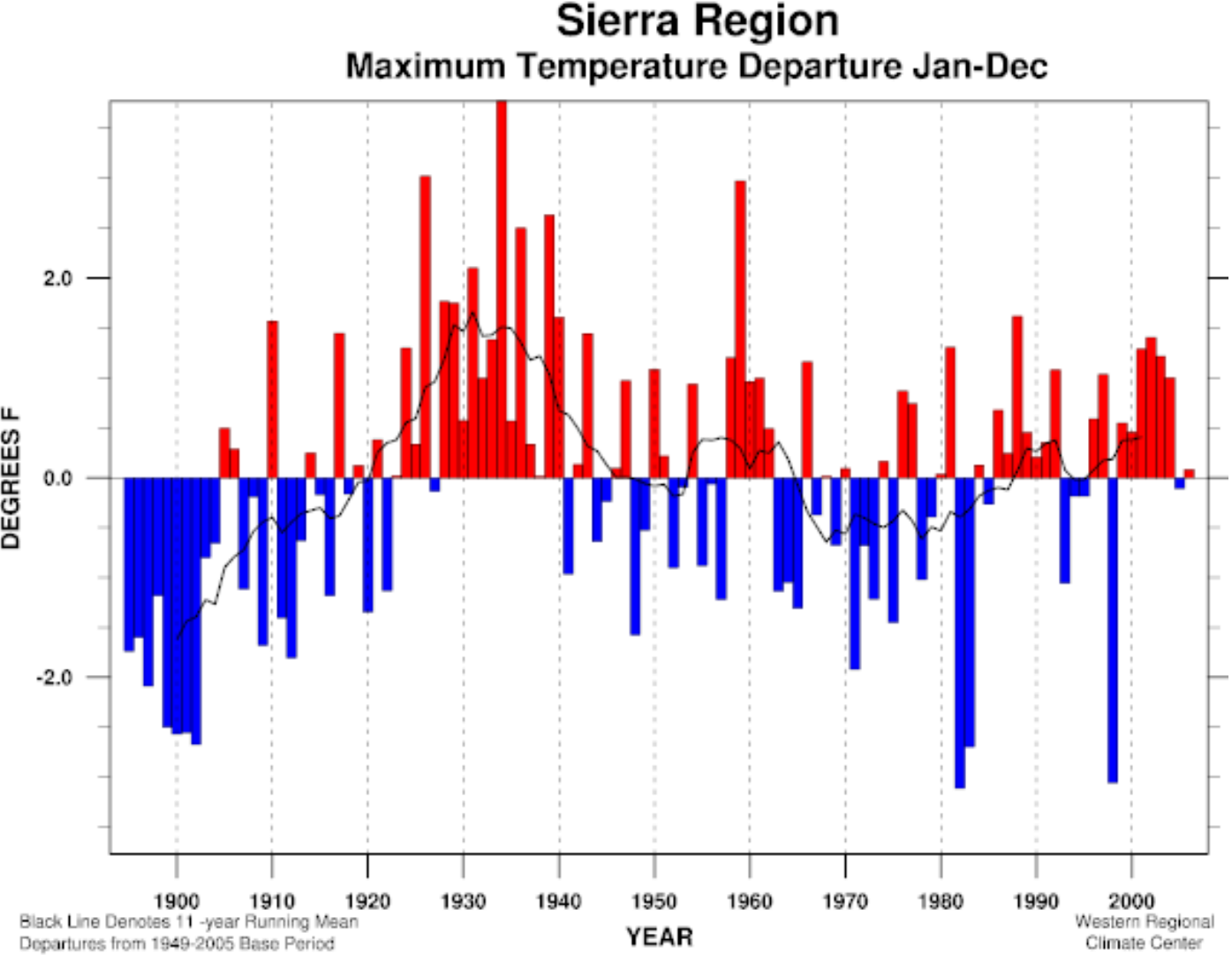
Linear Trend 1895-present + 1.35 ± 0.55 °F/100yr

Linear Trend 1949-present + 2.53 ± 1.43 °F/100yr

Linear Trend 1975-present + 5.64 ± 3.50 °F/100yr

Warmest Year		53.6 °F (+ 2.7 °F) in 1934	MEAN 50.8 °F
Coldest Year		48.5 °F (- 2.3 °F) in 1911	STDEV 1.04 °F
Jan-Dec	2006	51.9 °F (+ 1.0 °F)	RANK 95 of 112

Sierra Nevada Annual Mean Temperature



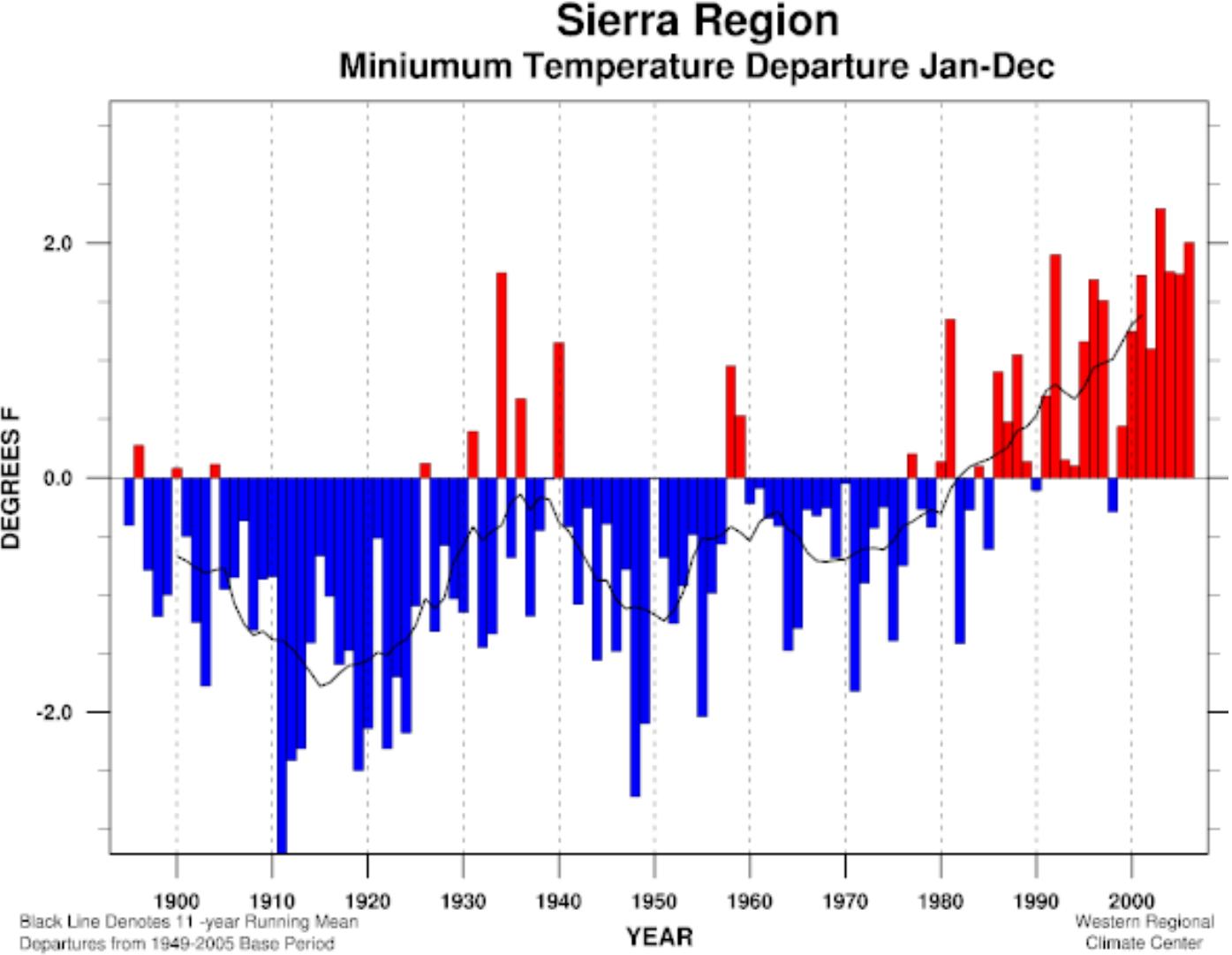
Linear Trend 1895-present + 0.69 ± 0.77 °F/100yr

Linear Trend 1949-present + 0.56 ± 1.82 °F/100yr

Linear Trend 1975-present + 3.47 ± 4.72 °F/100yr

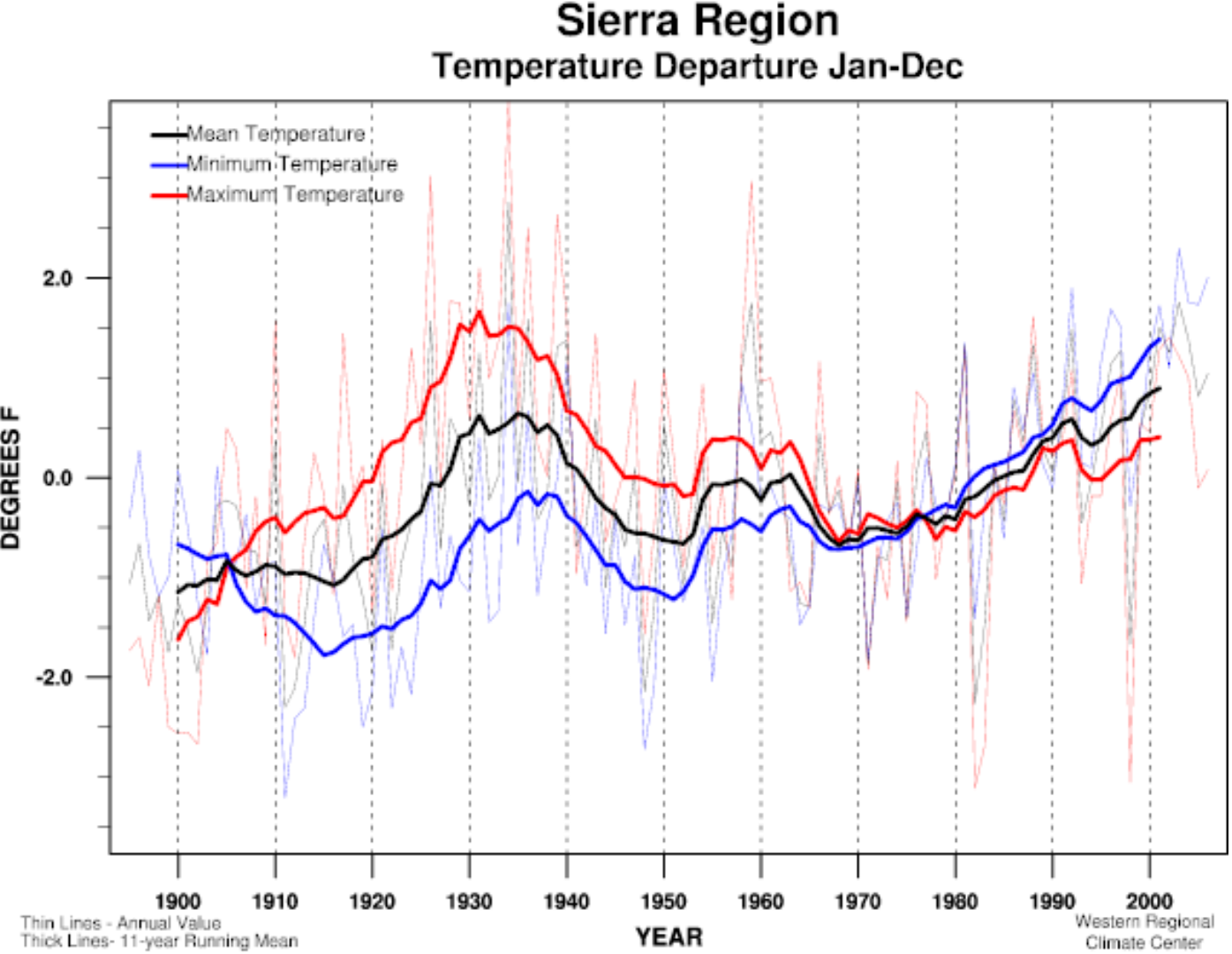
Warmest Year		67.0 °F (+ 3.7 °F) in 1934	MEAN 63.2 °F
Coldest Year		60.1 °F (- 3.1 °F) in 1982	STDEV 1.33 °F
Jan-Dec	2006	63.3 °F (+ 0.1 °F)	RANK 56 of 112

Sierra Nevada Annual Maximum Temperature



Linear Trend 1895-present		+ 2.01 ± 0.54 °F/100yr	
Linear Trend 1949-present		+ 4.50 ± 1.24 °F/100yr	
Linear Trend 1975-present		+ 7.80 ± 2.86 °F/100yr	
Warmest Year		40.8 °F (+ 2.2 °F) in 2003	MEAN 38.5 °F
Coldest Year		35.3 °F (- 3.2 °F) in 1911	STDEV 1.12 °F
Jan-Dec	2006	40.5 °F (+ 2.0 °F)	RANK 111 of 112

Sierra Nevada Annual Minimum Temperature



	Maximum Temperature	Minimum Temperature
Linear Trend 1895-present	+ 0.69 (± 0.77) °F/100yr	+ 2.01 (± 0.54) °F/100yr
Linear Trend 1949-present	+ 0.56 (± 1.82) °F/100yr	+ 4.50 (± 1.24) °F/100yr
Linear Trend 1975-present	+ 3.47 (± 4.72) °F/100yr	+ 7.80 (± 2.86) °F/100yr

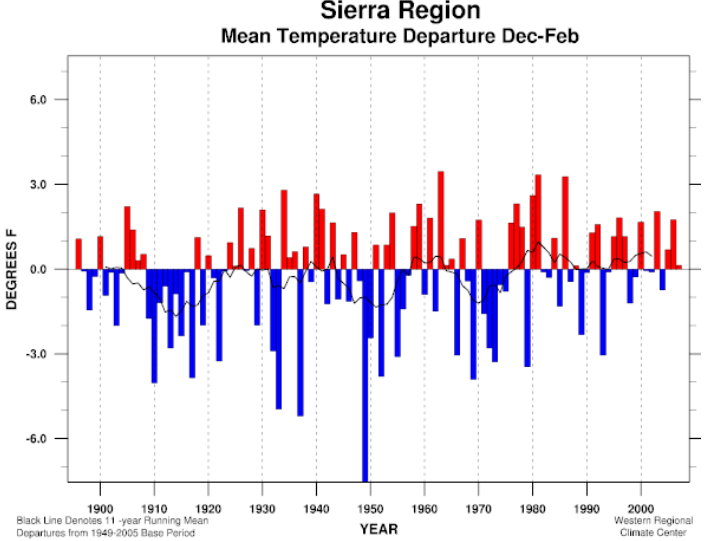
Sierra Nevada Annual Temperature Summary

Maximum
Mean
Minimum

Smoothed Plus Annual

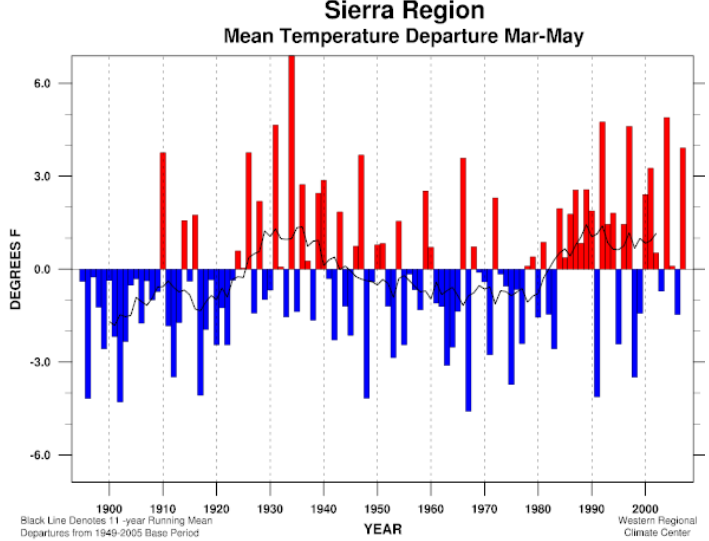
Sierra Nevada

Winter Temp



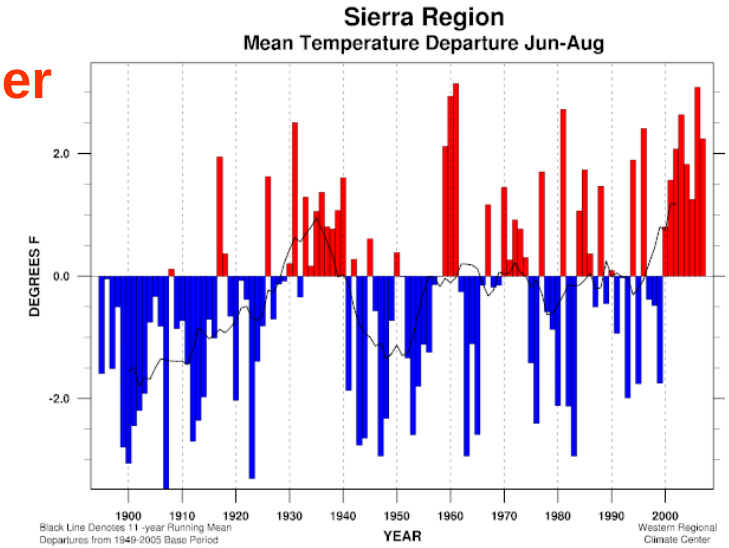
Linear Trend 1895-present	+ 0.94 ± 1.15 °F/100yr		
Linear Trend 1949-present	+ 2.00 ± 2.95 °F/100yr		
Linear Trend 1975-present	- 1.46 ± 6.48 °F/100yr		
Warmest Year	42.2 °F (+ 3.5 °F) in 1963	MEAN	38.8 °F
Coldest Year	31.2 °F (- 7.5 °F) in 1949	STDEV	1.90 °F
Dec-Feb 2007	38.9 °F (+ 0.1 °F)	RANK	64 of 112

Spring Temp



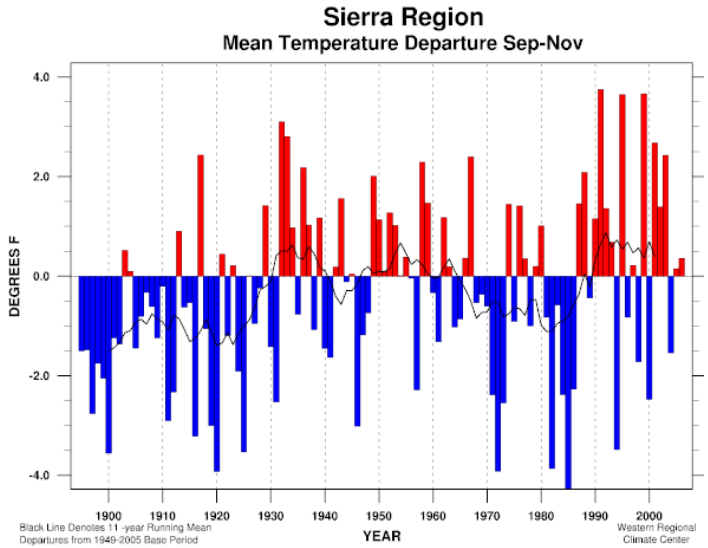
Linear Trend 1895-present	+ 1.65 ± 1.28 °F/100yr		
Linear Trend 1949-present	+ 4.04 ± 3.34 °F/100yr		
Linear Trend 1975-present	+ 8.49 ± 8.80 °F/100yr		
Warmest Year	54.3 °F (+ 6.9 °F) in 1934	MEAN	47.4 °F
Coldest Year	42.9 °F (- 4.6 °F) in 1967	STDEV	2.24 °F
Mar-May 2007	51.4 °F (+ 3.9 °F)	RANK	108 of 113

Summer Temp

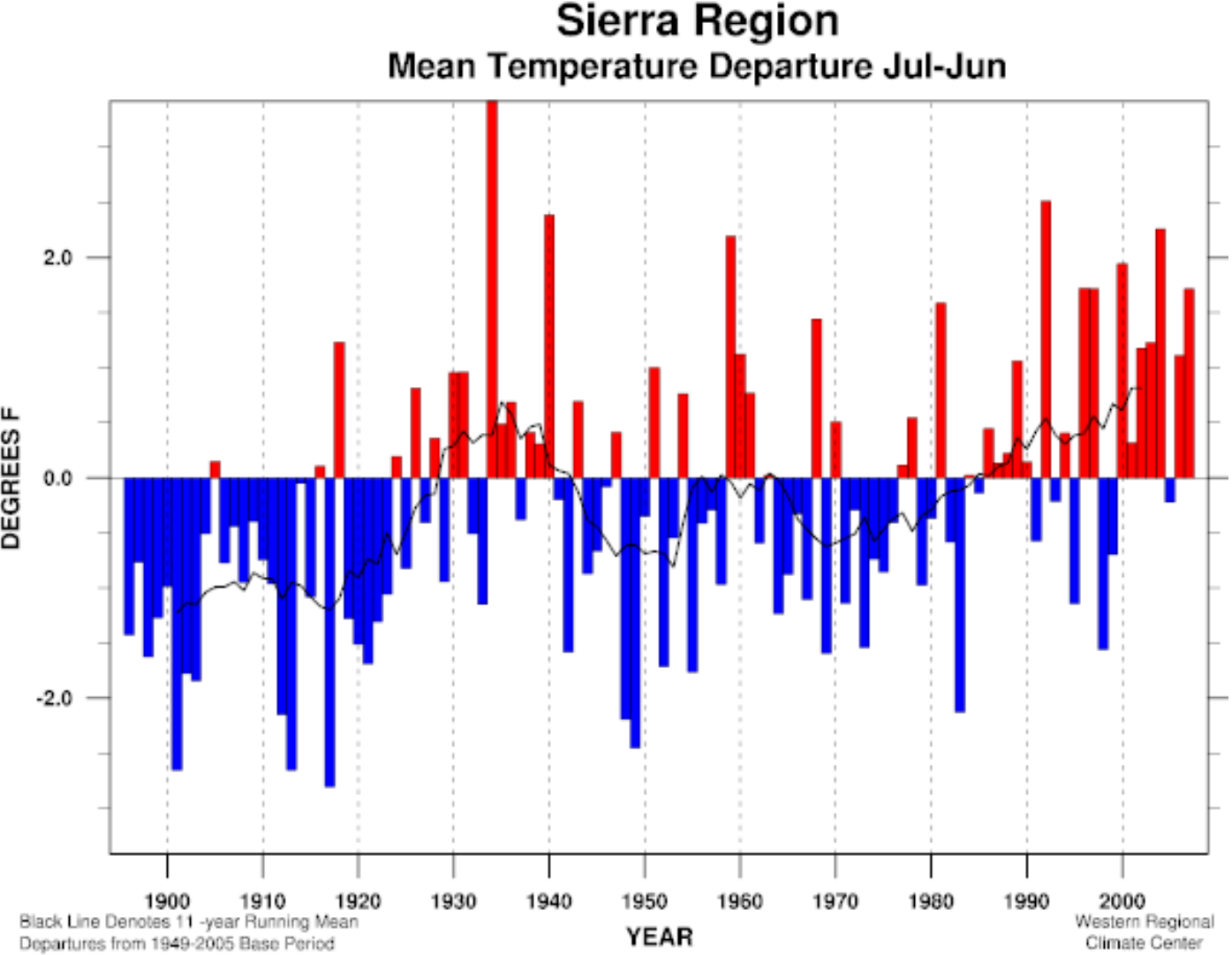


Linear Trend 1895-present	+ 1.83 ± 0.86 °F/100yr		
Linear Trend 1949-present	+ 2.88 ± 2.42 °F/100yr		
Linear Trend 1975-present	+ 8.62 ± 5.74 °F/100yr		
Warmest Year	69.3 °F (+ 3.1 °F) in 1961	MEAN	66.2 °F
Coldest Year	62.7 °F (- 3.5 °F) in 1907	STDEV	1.64 °F
Jun-Aug 2007	68.4 °F (+ 2.2 °F)	RANK	106 of 113

Fall Temp



Linear Trend 1895-present	+ 1.39 ± 1.01 °F/100yr		
Linear Trend 1949-present	+ 0.18 ± 2.98 °F/100yr		
Linear Trend 1975-present	+ 4.96 ± 8.23 °F/100yr		
Warmest Year	57.8 °F (+ 3.8 °F) in 1991	MEAN	54.0 °F
Coldest Year	49.7 °F (- 4.3 °F) in 1985	STDEV	1.88 °F
Sep-Nov 2006	54.4 °F (+ 0.4 °F)	RANK	76 of 112



Linear Trend 1895-present + 1.46 ± 0.64 °F/100yr

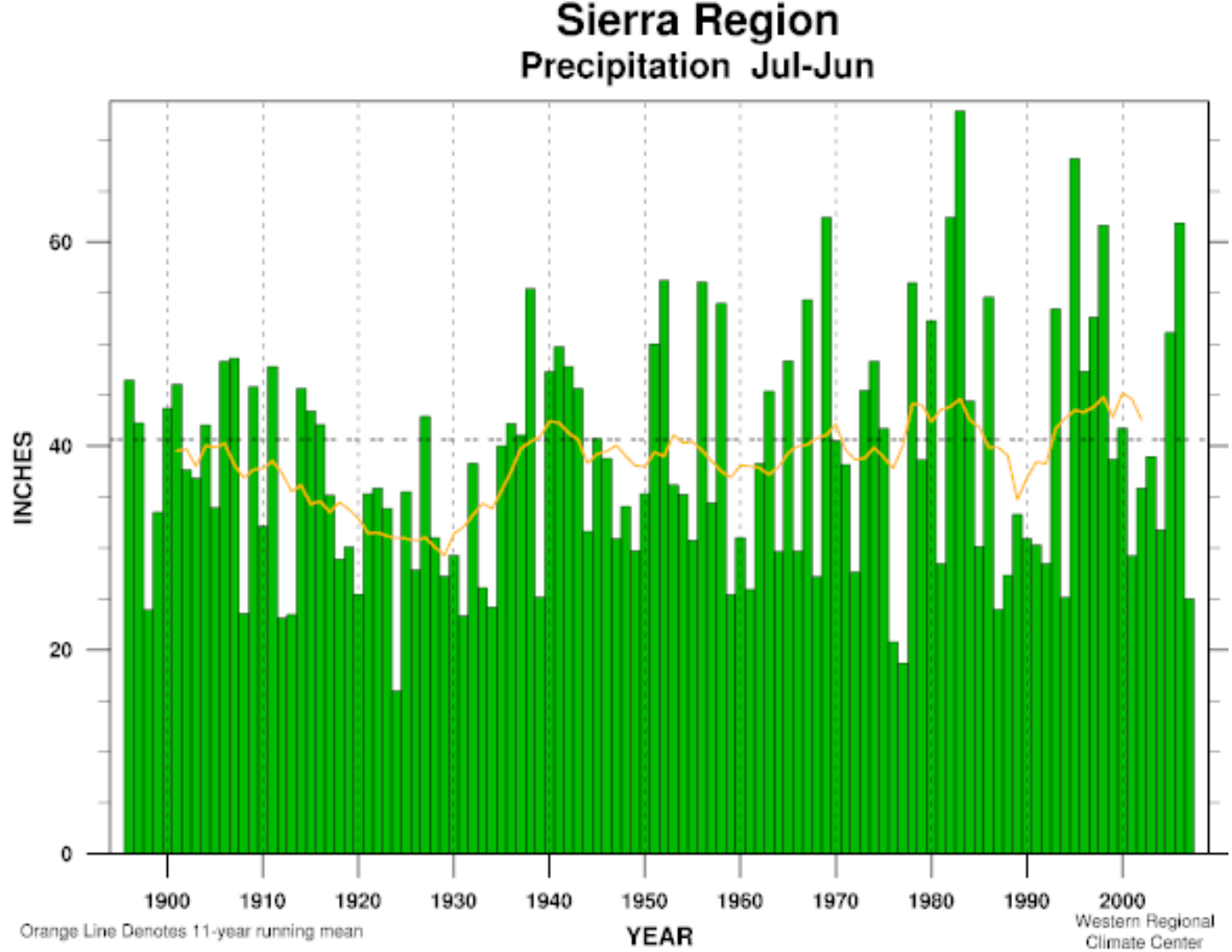
Linear Trend 1949-present + 2.31 ± 1.68 °F/100yr

Linear Trend 1975-present + 4.71 ± 4.10 °F/100yr

Warmest Year		55.0 °F (+3.4 °F) in 1934	MEAN 51.6 °F
Coldest Year		48.8 °F (- 2.8 °F) in 1917	STDEV 1.13 °F
Jul-Jun	2007	53.3 °F (+1.7 °F)	RANK 105 of 112

Sierra Nevada Winter-Centered July – June Temperature

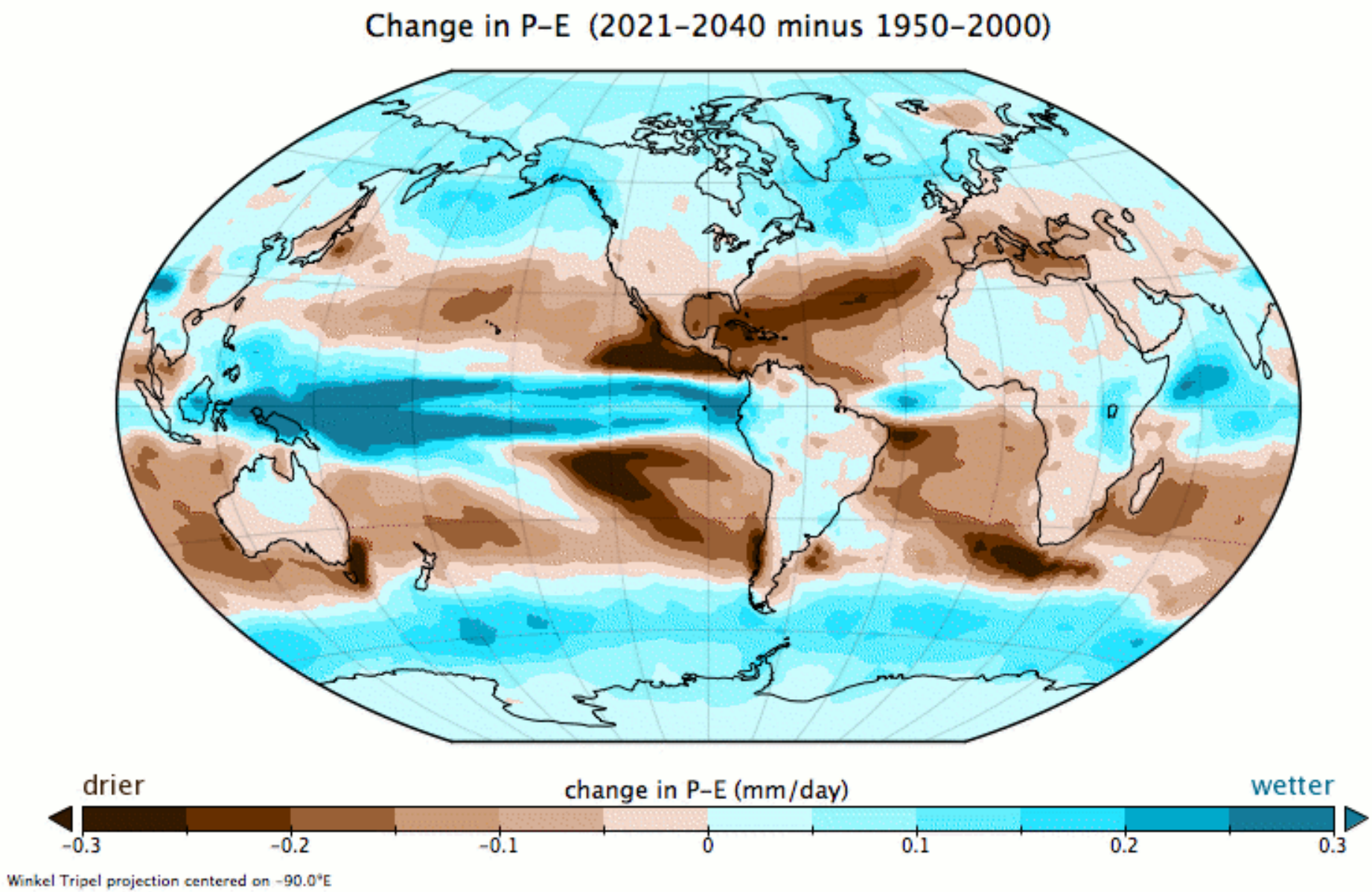
Thru June 2007



Linear Trend 1895-present	+ 6.26 ± 6.58 in.	(+ 15 ± 16%) per 100 yr	
Linear Trend 1949-present	+ 4.17 ± 20.80 in.	(+ 10 ± 51%) per 100 yr	
Linear Trend 1975-present	+10.88 ± 59.09 in.	(+ 26 ± 145%) per 100 yr	
Wettest Year	72.82 in. (179%)	in 1983	MEAN 40.65 in.
Driest Year	15.94 in. (39%)	in 1924	STDEV 13.10 in.
Jul-Jun 2007	25.01 in. (61%)		RANK 11 of 112

Sierra Nevada
Winter-Centered
12-Month
July - June
Precipitation

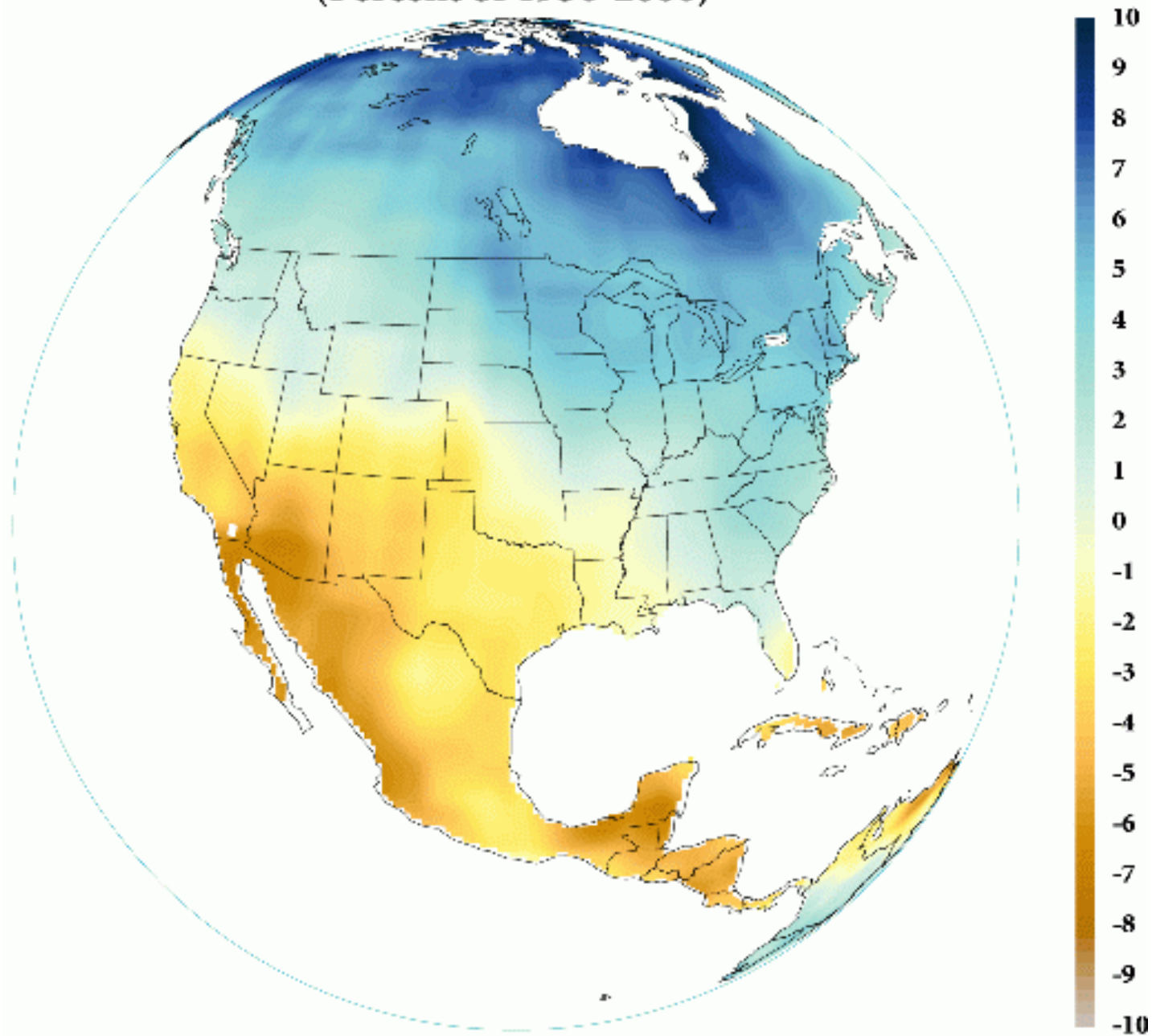
Thru June 2007



Seager et al, 2007. Average of 19 climate models. Figure by Naomi Naik.

www.ldeo.columbia.edu/res/div/ocp/drought/science.shtml

Projected Change in Precipitation 1950-2000 to 2021-2040
(Percent of 1950-2000)



Average of 19 climate models. 2007.

Figure by Gabriel Vecchi.

www.ldeo.columbia.edu/res/div/ocp/drought/science.shtml

R. Seager, M.F. Ting, I.M. Held, Y. Kushnir, J. Lu, G. Vecchi, H.-P. Huang, N. Harnik, A. Leetmaa, N.-C. Lau, C. Li, J. Velez, N. Naik, 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science*, DOI: 10.1126/science.1139601

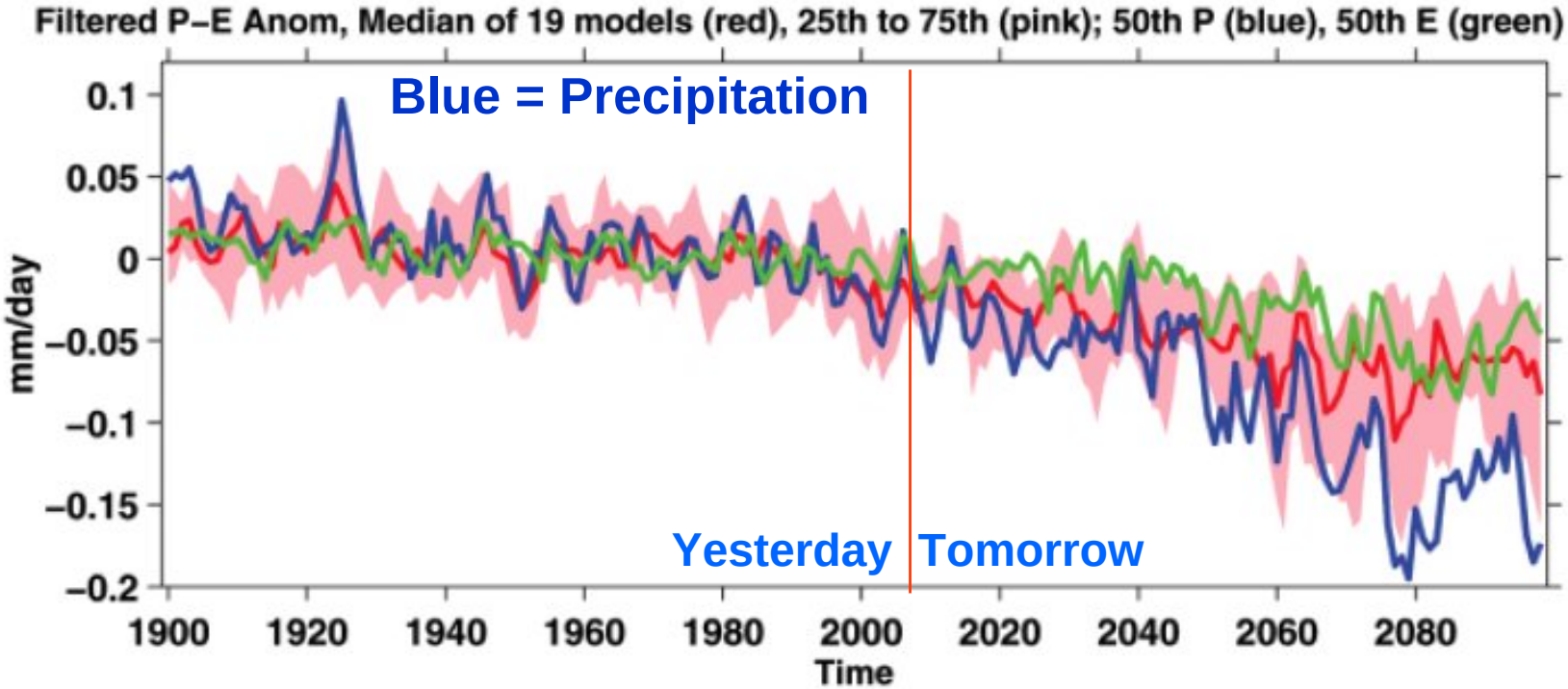
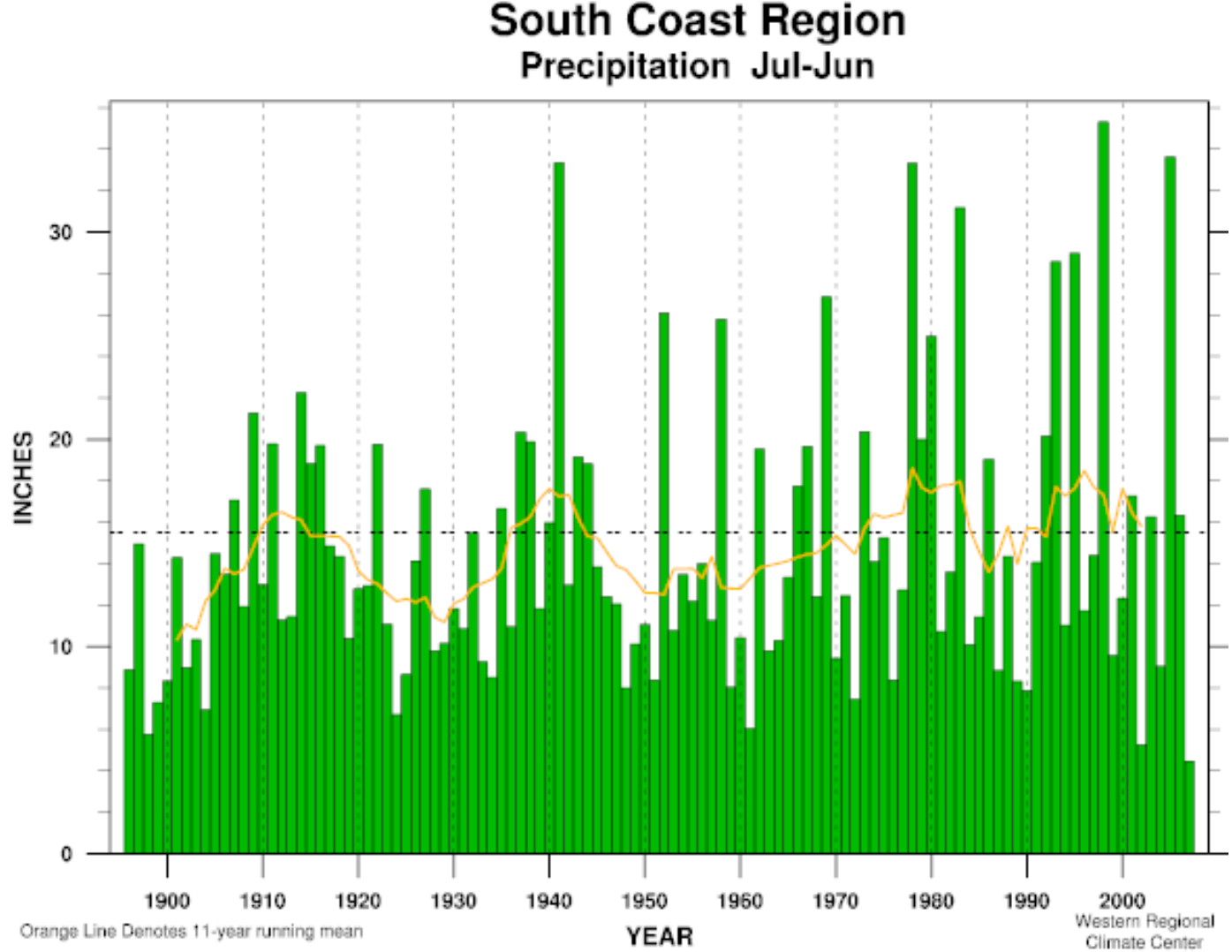


Fig. 1. Modeled changes in annual mean precipitation minus evaporation over the American Southwest (125°W to 95°W and 25°N to 40°N, land areas only), averaged over ensemble members for each of the 19 models. The historical period used known and estimated climate forcings, and the projections used the SResA1B emissions scenario. The median (red line) and 25th and 75th percentiles (pink shading) of the $P - E$ distribution among the 19 models are shown, as are the ensemble medians of P (blue line) and E (green line) for the period common to all models (1900–2098). Anomalies (Anom) for each model are relative to that model's climatology from 1950–2000. Results have been 6-year low-pass Butterworth-filtered to emphasize low-frequency variability that is of most consequence for water resources. The model ensemble mean $P - E$ in this region is around 0.3 mm/day.

Seager et al, 2007.



Linear Trend 1895-present	+ 3.71 ± 3.73 in.	(+ 23 ± 24%) per 100 yr	
Linear Trend 1949-present	+ 5.24 ± 12.00 in.	(+ 33 ± 77%) per 100 yr	
Linear Trend 1975-present	- 7.09 ± 34.77 in.	(- 45 ± 224%) per 100 yr	
Wettest Year	35.32 in. (227%)	in 1998	MEAN 15.51 in.
Driest Year	4.47 in. (28%)	in 2007	STDEV 7.56 in.
Jul-Jun 2007	4.47 in. (28%)		RANK 1 of 112

July-June Precipitation

South Coastal California

1895-1896 thru 2006-2007

Conclusions

There is coherent large scale temperature structure that appears to be real

The state is warming

- By how much ? 1-2 F / century, faster lately (1.5 F / 50 yrs) last 56 years
  - … not all biases yet accounted for
- TMIN warming more than TMAX

Continued real need for baseline observations with unchanging exposures

Statewide average temperatures correlate reasonably well with most of the state

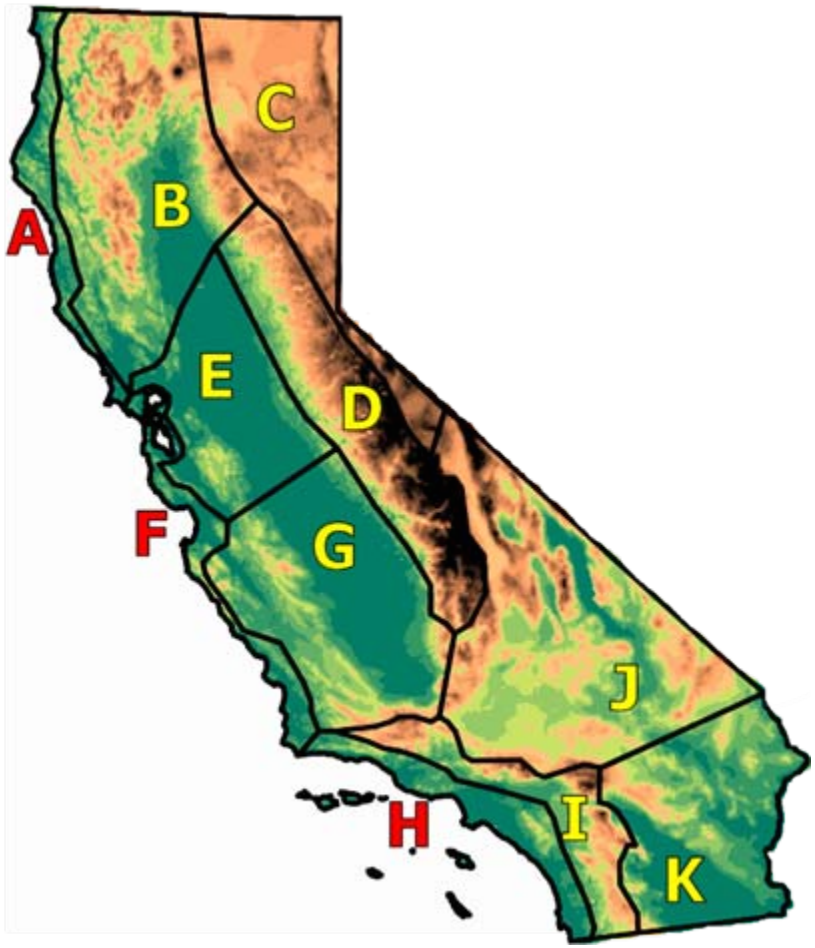
- Biggest exception: The Coast

Expert judgments that led to the NCDC Climate Divisions mostly well-founded

- Coastal strip stands out. Very narrow
- Northeast and US 395 corridor, and desert, need more refinement

Tracking indexes are quite feasible

A. www.wrcc.dri.edu/monitor/cal-mon/index.html
B. google “california climate tracker”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Discarded Slides

Data

NOAA Summary of the Day (SOD) Cooperative Network

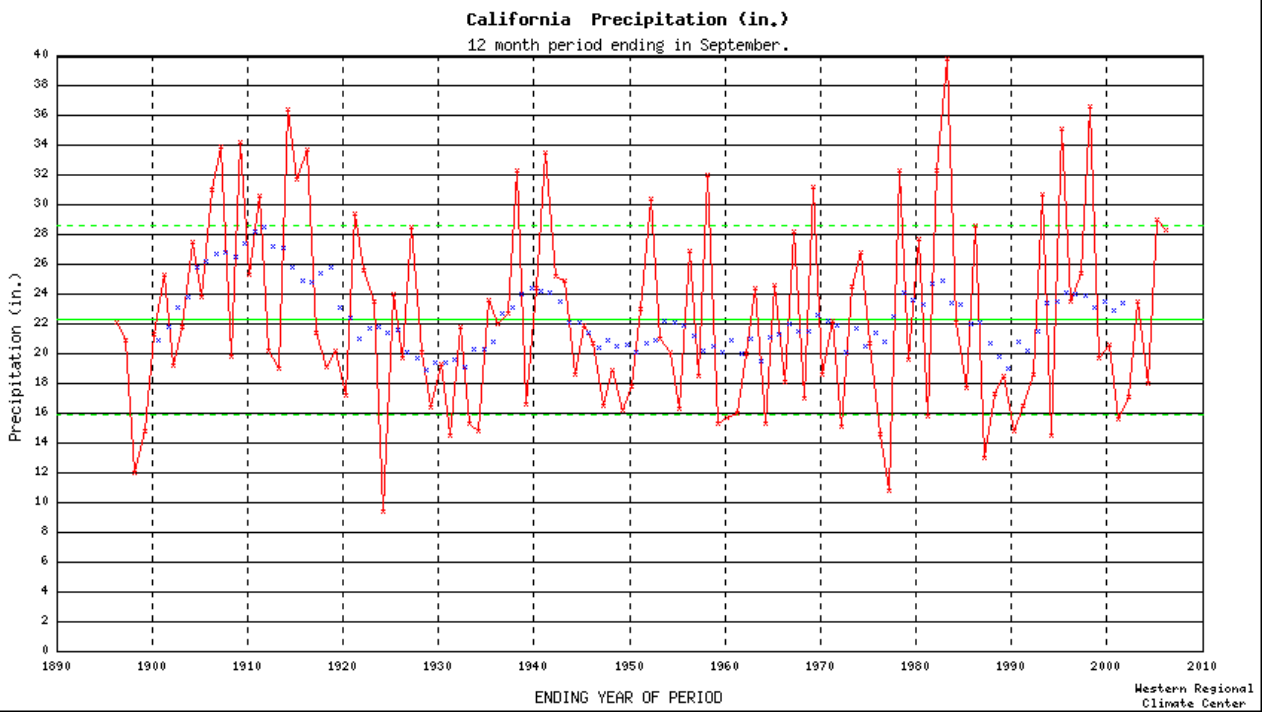
Summarized to monthly time scale
Month is “present” if no more than 5 missing days
At least 75 percent of all months with data July 1948 – June 2006
(Will later cover the entire century)
In operation during January 2006

TMAX - 197 stations. TMIN - 195 stations TPCP - 200 stations

Infilling: Need techniques that have minimal effect on long-term variability

PRISM Gridded Monthly data

January 1895 through June 2006
4 km time series aggregated to 24 km grid for California



California Statewide Precipitation

Water Year

Oct-Sep

1895-96 / 2005-06

NCDC Climate Divisions

California Statewide Temperature

Water Year

Oct-Sep

1895-96 / 2005-06